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DEPARTMENT OF AGRICULTURE
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ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1955

The organization of the Entomological Section during the year consisted of headquarters at the Scott Agricultural Laboratories with outstations in the Rift Valley, Nyanza and Coast Provinces, at Nakuru, Kibos and Matuga. Headquarters deal with administration, general investigations, general advisory work, insect identification and plant protection services. Nakuru deals with cereal pests, Kibos with cotton and sorghum pests, Matuga with coco-nut and citrus pests and all these stations with other general investigations and advisory work.

Plant Protection

NEW LEGISLATION

Linseed and flax seed were included in the scheduled list of seeds (G.N. 597, 10th April, 1953). The following plants including seed have been prohibited entry into Kenya:— Indian hemp (*Cannabis sativa*), coca (*Erythroxylum coca*) and poppy (*Papaver somniferum*) (G.N. 379, 19th March, 1955).

IMPORTATION OF PLANTS

Plant importation permits issued during the year totalled 1,797, an increase of nearly 400 on the 1954 figure. Parcels imported through the Post Office and inspected at the Scott Laboratories numbered 2,708. A large number of consignments were inspected at Eastleigh Airport, Nairobi West Aerodrome and the Railway Station, Nairobi. Several visits weekly were made to the Customs passenger section at Eastleigh Airport in order to inspect consignments brought into the country as personal baggage. A large number of consignments consisted of fresh fruit from South Africa, without permit or any certificates, and these had to be refused importation. The public are again reminded of the necessity of applying for plant importation permits before bringing to the country any plant material including flowers and fruit. Revenue collected from fines amounted to Sh. 492.

EXPORT OF PLANTS

A large number of consignments of plant material were received for examination and the issue of plant health certificates. After examination, and when necessary fumigation, plant health certificates were issued for 541 consignments.

INSECTS INTERCEPTED

Many of the intercepted insects have not been identified up to the present. They include: Thrips, aphids, dipterous larvæ, mites on cut flowers from South Africa. Some consignments from South Africa also contained elaterid beetles and ants. It is very rare for a consignment of cut flowers not to be infested with thrips, and other insects or mites are frequently present. A number of species of coccids were intercepted on chikoo fruits, mangoes and grapefruit from India. Among the identified insects *Parlatoria proteus* was intercepted from Israel, *Aulacaspis cinnamomi* on mango from India. Fungi were intercepted on various crops, but these have not been identified.

FUMIGATIONS

During the year many fumigations were carried out with HCN gas on cut flowers from the United Kingdom, with ethylene dibromide on mangoes from India and methyl bromide on stored products.

Thanks are given to the Senior Plant Pathologist for his help and that of his section throughout the year. Thanks are also given to the Chief Grader and Inspector and his staff for their helpful co-operation. Our thanks also go to the Customs officers and their staff for their helpful co-operation with this Department.

Stored Products

The Pest Infestation of Stored Products Committee held five meetings during the year. This is an interdepartmental committee advisory to the Minister for Agriculture which deals with all subjects both administrative and technical in connexion with pests attacking stored products. At these meetings the general research programme is agreed, and this is carried out by Maize Control staff working in the Entomological Section of the Department, and coming for this purpose directly under the Senior Entomologist.

Mrs. J. Wells reports on experimental work as follows:—

"Insecticidal Resins"

The experiment put up on the walls of a store in May, 1954, was concluded in November, 1955. The formulation containing 20 per cent D.D.T. and 2 per cent B.H.C. was very effective up to 10 months against both *Calandra oryzae* and *Tribolium castaneum*, but after 18 months it was no longer fully effective, although it was still more effective than 5 per cent B.H.C. plus 10 per cent D.D.T., or 5 per cent aldrin plus 10 per cent dieldrin.

Treatment of railway trucks

A railway truck was treated with ureaformaldehyde resin containing 20 per cent D.D.T. and 2 per cent B.H.C. in March, 1955. The truck was thereafter in general railway use and a biological test of the surface after six months using *Calandra oryzae*, gave a kill of over 80 per cent. This experiment is still continuing. A number of other experiments in railway trucks were begun.

Ureaformaldehyde resins containing B.H.C. and D.D.T., and aldrin and dieldrin applied in lake steamers were considered to be very effective against cockroaches. The aldrin and dieldrin resin was applied in a domestic kitchen and proved completely effective after 18 months, with no sign then that effectiveness was decreasing.

Stack treatments

A small scale experiment was carried out on the penetration of insecticides into grain when the outside of the bags is treated. Indications were that heavy dusting with 1 per cent lindane in kaolin may lead to a concentration of B.H.C. above the permitted limit becoming mixed with the grain at least in the outside layers, but a spray of 2½ per cent D.D.T. wettable powder was found to penetrate very little through the bag fabric. It was also found that kaolin penetrated bag fabric more than twice as readily as diatomite. Experiments were begun on the protection to be afforded by various dusting and spraying treatments of bag stacks."

Mr. Kockum reports as follows:—

"Fumigation in stacks"

Large-scale fumigations with methyl bromide under gasproof sheets were started by Maize Control at the end of 1954 at Mombasa. During the first half of 1955 all export maize was fumigated at the port. This consisted of new crop maize of good quality and only slightly insect infested. The dose used was 1½ lb. per 1,000 cu. ft. for 24 hours. The results seemed to be good, though a few shipments were found to have light infestations on arrival in England. When later in the season maize was fumigated up-country, in large stacks up to 20,000 bags, failures were encountered and heavy reinfestation occurred some seven weeks after fumigation. Trial fumigations with different dosage and exposure times were carried out at Kisumu and Nairobi. It was found that good results were not obtained with exposure times shorter than

48 hours with a dose of 2 lb. per 1,000 cu. ft. The heavy infestations with resulting damage to the grain certainly influenced the results. The primary pests, *Calandra oryzae* and *Sitotroga cerealella*, were eliminated at lower concentrations. *Tribolium* and *Oryzophilus* were the species causing difficulty. Gas sampling experiments are planned in the coming year to explore the technique to be used in large stack fumigation under our conditions.

Insecticides in bag

Experiments were set up with full bags of maize to study the effect of placement of B.H.C. and testing pyrethrin/piperonyl butoxide in pyrethrum marc, and oil-free pyrethrum/piperonyl butoxide. The results will not be available before next year.

Crib experiment

A large size crib experiment was completed. In earlier crib experiments it had been shown that insect damage could be almost completely controlled, by dusting the cob maize with B.H.C. diatomite powder. Only a small amount of damage occurring and this on exposed surfaces. Dusting the surfaces with pyrethrum powder failed to give protection. In this experiment the effect of different types of crib walls was tried. These consisted of ordinary wire-netting, grass thatch, napier grass, hessian and hessian treated with B.H.C. plus coumarone resin. No difference could be found between these treatments and ordinary wire-netting walls except in the case of B.H.C.-coumarone treated hessian, which had a most unexpectedly good result. This treatment will be further examined in a new experiment to be started early in 1956."

Entomological Investigations—Rift Valley Province

Mr. Graham, Entomologist, Rift Valley, reports as follows:—

"Serious insect pest problems did not occur during the year. Some pest activity followed abnormal rain in February but a drought occurred in June and July which severely restricted this.

Barley fly (Hylemyia arambourgi)

This fly appears to occur throughout the year and there does not appear to be a resting stage. As barley has a restricted planting season an alternative host plant probably exists. The eggs are about 1 mm. in length and white in colour. They are laid on or near barley seedlings and hatch under indoor conditions, in about four days. The young maggot enters a seedling and bores downwards. In doing so it cuts the central shoot which withers; sometimes the entire seedling is killed. It then passes to another tiller killing three or four before it pupates 11 or 12 days later. The pupa is formed in the soil or remains of a tiller and the fly emerges from it about a fortnight later. The adult fly is yellowish-grey and rather smaller than a house-fly. It occurs in shady positions during the heat of the day, often in considerable numbers.

Spraying experiments were carried out on infested crops and by dressing the seed before planting. The latter appears to be the more satisfactory method of control and is much less expensive than field spraying. Of the materials tested an endrin emulsifiable concentrate (19.5 per cent endrin) at 2.4 pints per acre was slightly better than a chlordane emulsion (10 lb. of chlordane per gallon) also at 2.4 pints per acre. Both materials were better than emulsions of aldrin, dieldrin and D.D.T. and malathion wettable powder. Seed dressings gave good control, particularly endrin, aldrin, dieldrin and chlordane. Gamma B.H.C. dressings and dusts of D.D.T., malathion and diazinon give only partial control.

Endrin emulsifiable concentrate (19.5 per cent endrin) was used since dust was not available. It gave good results at $\frac{1}{2}$ pint to 80 lb. of seed. At 1 pint to 80 lb. of seed it gave virtually complete control. The seed is dressed by pouring the liquid over the seed and mixing thoroughly by hand, wearing rubber gloves. The seed is then spread out in a thin layer where it dries quickly. It can then be treated with a fungicidal dressing if necessary.

Aldrin was used at 12 oz. of 40 per cent wettable powder to 100 lb. of seed. This gives good but not complete control. An aldrin emulsion (2.4 lb. aldrin per gal.) can be used at 1 pint to 80 lb. of seed as for endrin above. This gives a higher concentration of aldrin, as well as being cheaper, than the wettable powder. Dieldrin was used as a 50 per cent wettable powder and as a proprietary dressing of unknown strength. Both gave good control at 4 oz. to 80 lb. of seed but a heavier concentration may be needed for heavy infestations. A dieldrin emulsion can be used as for endrin above.

Chlordane was unsatisfactory as a 50 per cent dust at 4 oz. to 80 lb. of seed. A chlordane emulsion (10 lb. chlordane per gallon) used at $\frac{1}{2}$ pint to 80 lb. of seed gave almost complete control though germination rate was lowered. Even at half this strength germination was retarded and some seedlings were distorted. For dressings with chlordane emulsion water to make up a pint (or more) of liquid should be added for every 80 lb. of seed.

Maize stalk borer (Busseola fusca)

The work programme on this pest had to be curtailed as heavy infestations could not be found. In hand-dressed maize an infestation of 5 per cent was noted where 1 per cent D.D.T. dust was applied. Where a derris emulsion was used the infestation was 21 per cent, while in untreated maize 28 per cent of the plants were affected. A tractor sprayer was also used with all the nozzles in operation. After the tractor application of endrin (1 pint of 19.5 per cent emulsion to 20 gallons of water) an infestation of 6 per cent was found. After D.D.T. emulsion (3 pints/10 gallons of water) an infestation of 7 per cent was recorded in one case and 3 per cent in another. The stand of maize used was poor and the spraying was carried out later than usual because of lack of infestation. Better results could be expected with (1) maize sprayed when younger and (2) the sprayer jets directed towards the maize plants. Work on the latter is planned for 1956.

Black wheat beetle (Heteronychnus consimilis)

Very good control was obtained in maize at Nakuru by the use of 1 lb. of 40 per cent aldrin wettable powder as a dressing to 200 lb. of seed. At Ol Kalou seed dressings of 40 per cent aldrin and 40 per cent gamma B.H.C. were used for wheat. Both treatments were vastly superior to no treatment.

Harvester ants

A successful method of control was spraying around the nest with a dieldrin emulsion (1 to 100 of water). An aldrin bait was found to be cheaper and just as effective. One ounce of 40 per cent aldrin powder was mixed thoroughly with 2 lb. of maize posho and applied to the nest entrances at about 2 oz. per nest. This killed most of the nests treated, but in a few cases a second application was necessary a month later.

Cereal aphids.

Good control of *Schizaphis graminum* and of *Rhopalosiphum maidis* was obtained by the use of malathion 50 per cent emulsion at 2 fl. oz. to 5 gallons of water or diazinon 60 per cent at 1 fl. oz./5 gallons. On a field scale *Schizaphis* was controlled by 1 pint of 50 per cent malathion in 25 gallons of water per acre at about 56 lb. per square inch pressure. A tractor-mounted boom sprayer was used."

Entomological Investigations—Coast Province

Mr. Wheatley, Entomologist, Coast Province, reports as follows:—

“Progress has been made in the collection, identification and assessment of importance of insect pests attacking agricultural crops in the Coast Province. In particular studies have been made of coco-nut and citrus, although numerous pests have also been collected from other crops. The principal cereal stalk borers from the different districts of the Province have been submitted for identification.

The Coreid bug (Pseudotheraptus wayi)

This pest continued to cause severe nutfall of coco-nuts, especially in the drier areas where the predaceous ant *Oecophylla longinoda* is usually absent. An experiment has been laid down to find ways of encouraging *Oecophylla*, but results are not yet available. Examination of several hundreds of damaged and undamaged nuts has shown that apart from immature nutfall, which constitutes the major proportion of damage caused by the Coreid bug, the copra content of nuts which are damaged but reach maturity is approximately 20 per cent lower than that of undamaged nuts.

Rhinoceros beetle (Oryctes monoceros)

This insect is the principal agent causing the loss of otherwise healthy coco-nut palms, a fact rarely appreciated by growers. A reliable estimate made at Gazi showed that during 1955 approximately 2 per cent of mature and healthy palms died as a result of Rhinoceros beetle attack. This means that in a well-managed plantation approximately 15 per cent of the palms are not bearing at any time due solely to this pest. This proportion would be considerably higher on many African smallholdings as replanting is often not carried out for many years after the palms have been lost.

Homorocoryphus vicinus

A large swarm of this grasshopper caused some damage to the rice crop at Vanga. Initial steps were taken to control the pest by baiting but fortunately the timely advent of rain caused the swarm to disperse, and damage was restricted to only a small proportion of the crop. Although individual insects were subsequently found in all the areas of the south coast, only on one occasion was a further swarm encountered and that was a small one at Matuga which fed on wild grass seeds. *Chrotagonus* sp. and other grasshoppers damaged many crops grown at the coast, especially vegetables, by eating the shoots when they first appeared above ground. Destruction of the seedlings was often 90 per cent and necessitated resowing. Adequate control was achieved with dieldrin emulsion.

The false codling moth (*Argyroploce leucotreta*) populations were higher than usual this year, and a considerable loss of oranges and grapefruit occurred, and to a lesser extent, chillies.

Citrus bud mite (*Aceria sheldoni*) has been collected from all the citrus areas of the coast. Its presence in many places which are well isolated from other citrus areas indicates that this pest has been established at the coast for a very long time. Similarly, citrus rust mite *Phyllocoptruta oleivorus* is distributed over the whole Province and has probably been here for a long time. This latter pest is of importance in that it gives the fruit a most unattractive appearance.

Teleonemia scrupulosa, introduced to Kenya from Hawaii to control *Lantana*, has been established at Matuga. It is not expected that this insect alone will give adequate control of this weed, and it is still too early to assess its importance.

A search for the predatory snails *Gonaxis* and *Edentulina* was made in the Diani Beach area with little success. Requests for these predators have been received from several countries for the control of the Giant African Snail, *Achatina*.

Experiments with Insecticides

Soft scale of citrus (*Coccus hesperidum*). Diazinon at 0.075 per cent gave a better control of this pest than malathion 0.19 per cent or 2.5 per cent white oil with nicotine.

Citrus red spider mite (*Eutetranychus banksi*). For an experiment designed to find an effective control of this pest, which has a very wide host range, laboratory work was first carried out to determine the optimum intervals between sprayings of ovicidal and non-ovicidal acaricides. A satisfactory method of rearing the mites on small potted orange seedlings was devised, and its life history studied. The limits of the duration of the egg stage was $4\frac{1}{2}$ to $5\frac{1}{2}$ days (average 5) and the time for the complete life cycle was 10 to 13 days (average 11). The intervals recommended between sprayings or acaricides are 4 or 5 days for ovicides, and 6 days for non-ovicidal materials. Laboratory tests showed that p-chlorobenzyl p-chlorophenyl sulphide at 0.025 per cent gave a good kill of eggs, but residual toxicity was nil and there was no appreciable effect on the active stages. Chlorobenzilate at 0.025 per cent active ingredient gave a good kill of active stages, a fairly good kill of eggs, and residual toxicity was high for a period of seven days after spraying.

Spraying of the field trial was carried out with an orchard sprayer at a pressure of 350 lb./sq. in., with the following materials:—

- 0.025 per cent p-chlorobenzyl p-chlorophenyl sulphide (1, 2 and 3 applications each).
- 0.03 per cent chlorobenzilate (1, 2 and 3 applications each).
- 0.075 per cent diazinon (1 and 2 application each).
- 2.5 per cent white oil (1 and 2 applications each).
- 0.19 per cent malathion (1 and 2 applications each).

Good control was achieved by single sprayings of white oil and of diazinon, which applications appeared to have very little effect on the population of the predatory mite *Amblyseius caudata*. The other materials, by destroying this predatory mite, allowed reinfestations of *Eutetranychus banksi* to build up to high populations in a very short time.

All the treatments in this experiment gave a good control of citrus rust mite (*Phyllocoptruta oleivorus*) with the exception of the p-chlorobenzyl p-chlorophenyl sulphide treatments and the single application of malathion. Citrus bud mite (*Aceria sheldoni*). Single, double and treble sprayings of 0.025 per cent p-chlorobenzyl p-chlorophenyl sulphide (five-day intervals) and 0.03 per cent chlorobenzilate (six-day intervals) were applied as a pressure of 350 lb. per sq. in. Of these treatments the double and treble sprayings of chlorobenzilate gave a very good control, reducing the percentage of infested buds from over 75 per cent to less than 3 per cent at three weeks after spraying and less than $4\frac{1}{2}$ per cent three months after spraying. The growth response of the trees to these treatments was considerable.

False codling moth (*Argyroplote leucotreta*). A simple trial to test the efficacy of two applications of endrin emulsion at 0.075 per cent with a three-week interval between applications, indicated that this insecticide gives a partial control of the pest, and that its use under normal conditions would not be economic."

Entomological Investigations—Nyanza Province

Mr. Crowe, Entomologist, Nyanza, reports as follows:—

"The work in Nyanza continued to be mainly on cotton pests. This season will not finish till March, 1956, so conclusions are only provisional.

Survey

Routine counts of cotton pests as described last year continued. In the Luo area cotton stainer (*Dysdercus* spp.) numbers were generally lower than last year. A population of 4,600 adults plus fifth instar nymphs per acre was recorded and this is lower than last year's maximum count. *D. supersticiosus* (30.9 per cent) and *D. nigrofasciatus* (68.1 per cent) were again the commonest species. *Lygus* damage was of the same order as 1954 but was somewhat more severe in the lake shore savannah regions than in Kano Plain. Bollworm attack, chiefly *Heliothis armigera* was responsible for 30.4 per cent of the shedding of young buds and bolls compared with 24 per cent sheds due to bug puncture but the bollworm attack was mostly at the beginning of the season and in view of the good rains later in the year, probably had little effect on final yield.

In the area adjacent to the Uganda border stainers were generally uncommon but there were local outbreaks at the end of the year following unseasonal rain. *Lygus* attack was severe. Accurate leaf grading was difficult owing to severe hail damage in many localities. Bollworms were responsible for only a small proportion of bud and boll shedding.

In all parts of the Province there was a smaller number of large mummified bolls than in 1954. Pink bollworms (*Platyedra gossypiella*) were common towards the end of the year in large bolls but over 50 per cent were parasitized by *Microbracon kirkpatricki*. Jassid (*Empoasca* spp.) caused noticeable damage to the variety UK.48 which is fairly resistant to this insect. In the area planted with S.47, a less resistant variety, a few damaged plants could be found everywhere but only rarely did a whole *shamba* show the characteristic symptoms.

Experimental

Pest assessment trials were planted at Kibos in the Luo area and Bungoma in North Nyanza. At Kibos, stainers caused the greatest losses by lowering both the quantity and the quality of the seed cotton harvested. Pests causing the shedding of buds and small bolls (*Lygus* and American bollworm) were responsible for only a small decrease in final yield. This experiment, however, because of early planting (March), very early ripening (August), and a typical pest attack was unfortunately not representative of the Luo area. A yield equivalent to 1,570 lb./acre was picked from the fully protected plots. Owing to delayed picking following unseasonal rain final yield figures have not been received from the Bungoma trial.

Ten small dusting trials were carried out on cotton planted in March and April in widely differing localities of the Luo area. The treatments (and average yields of these trials where picking is complete) are detailed below:—

- A.—100 lb. 3:10:0 cotton dust per acre in 5 × 20 lb. applications at ten-day intervals in August-September. Average yield 1,133 lb./acre (35.8 per cent stained).
- B.—60 lb. 3:10:0 cotton dust in 3 × 20 lb. applications at ten-day intervals in August-September. Average yield 890 lb./acre (37.5 per cent stained).
- C.—Untreated. Average yield 713 lb./acre (43.5 per cent stained).

In a trial at Kibos to compare these treatments with 3:5:0 cotton dust at the same rates, treatment *A* above significantly outyielded all others.

In another trial an arsenic/sugar bait gave good stainer control but malathion and B.H.C. baits which it was hoped might make good substitutes were disappointing under field conditions.

Sugar cane

Following the partial success of B.H.C. last year, trials were made of other chemicals against termites attacking cane planting material. Twelve unreplicated trials were laid down in North and South Nyanza the treatments being B.H.C. powder (2.6 per cent at 40 lb./acre) dusted into the planting furrow, 0.1 per cent dieldrin as a dip for setts and a control plot. The majority of the trials were subjected to intense termite attack. Dieldrin-treated plots invariably gave a good stand, B.H.C. gave some measure of control, but inferior to dieldrin. Control plots were in some cases completely destroyed.

Four replicated trials were also planted in North Nyanza. These have not yet been subjected to a severe dry spell nor have they been running long enough to estimate the persistence of the treatments. The following materials however show promise:—

- 1.0 per cent D.D.T. as a dip for setts.
- 0.1 per cent dieldrin as a dip for setts.
- 0.5 per cent dieldrin as a dip for setts.
- 2.5 per cent aldrin dust at 25 lb./acre in the planting furrow.

All these are superior to the B.H.C. treatment mentioned above.

Sorghum

A stalk borer control experiment was planted at Kibos. Spraying began on all plots as soon as young *Busseola fusca* caterpillars were found. Sprays were applied to near run off in all cases. Three applications at three-weekly intervals of 0.075 per cent endrin and three applications of 0.6 per cent D.D.T. at the same intervals gave a significant reduction in infested nodes, but neither one nor two applications of endrin or D.D.T. gave any perceptible reduction of infestation.

Miscellaneous

Excellent control of spiny caterpillar (*Achræa acerata*) on sweet potatoes was achieved by spraying with 0.2 per cent endrin. 0.2 per cent dieldrin gave some protection but was inferior to endrin. Yield figures are not complete but both larger and better quality potatoes have been taken from the treated plots.

The banana weevil (*Cosmopolites sordidus*) has been found widely but discontinuously distributed through Central and North Nyanza. The first record for South Nyanza was received this year. A small trial to test the protective effect of dieldrin has been put down. A larger trial with both chemical and cultural treatments has been planned for the new farm at Busia.

A galerucid beetle *Megalognatha reflecta* caused damage to maize cobs in North Nyanza by eating the freshly emerged silks and preventing fertilization of the grains. It was readily controlled with a 5 per cent D.D.T. dust.

The fruit fly *Craspedoxantha marginalis* attacked zinnia heads in Kisumu. It was controlled by removing the infested buds and flowers and spraying a bait composed of 0.04 per cent diazinon and 5.0 per cent sugar. A high percentage of pupæ were parasitized by a *Perilampus* sp."

Systematic Study of Coccidae

Mr. De Lotto continued his systematic study of the coccidæ and has identified many collections of coccidæ from other departments and East African territories. He continued the detailed study of the mealy bugs of Africa south of the Sahara (Ethiopian mealy bugs) and spent some months in London at the British Museum (Natural History) working in collaboration with Dr. Williams of the Commonwealth Institute of Entomology on this joint project. On his return from home leave he continued with his coccid work at the Scott Agricultural Laboratories.

Miscellaneous Pests

The following pests were recorded as doing damage during the year:— These include records of the entomologists in the Provinces, and advisory samples received at the Scott Laboratories.

COLEOPTERA—

<i>Volumnia westermanni</i> ..	<i>Lagenaria pattersoni</i> ..	Nairobi
<i>Paraphosphorus hololeucus</i>	Citrus	Limuru
<i>Dactylispa</i> sp.	<i>Pennisetum purpureum</i>	Machakos
<i>Carpophilus dimidiatus</i> ..	<i>Passiflora edulis</i> ..	Sotik
<i>Mesoplatys ochroptera</i> ..	<i>Sesbania</i>	S. Nyanza
<i>Apate monacha</i>	Coffee	Kabete
<i>Pachnoda sinuata</i>	Rose, mango	Nairobi
<i>Adoretus pagenstecheri</i> ..	<i>Bombax</i> sp.	Nairobi
<i>Megalognatha reflecta</i> ..	<i>Cajanus indicus</i> ..	Sotik
<i>Oxythyrea elegans</i>	Pear, apple, vegetables ..	Limuru
<i>Heteronychus consimilis</i> ..	Wheat	Nakuru
<i>Heteronychus</i> sp. ...	Maize	Nakuru
<i>Alcidodes leucogrammus</i> ..	Beans	Machakos
<i>Nematocerus</i> spp.	Roses, Tea	Limuru, Nyeri
<i>Nematocerus striolatus</i> ..	Tea	Nyeri
<i>Diaecoderus villosus</i>	Maize	Njoro
<i>Lagria viridipennis</i>	Coffee	Ruiru
<i>Eutochia pulla</i>	Wattle	Eldoret
<i>Diaetocera reticulata</i> ..	Fruit, indigenous trees ..	Mombasa
<i>Systates crenatipennis</i> ..	Tea	Karatina
<i>Peribrotus</i> sp.	Tea	Karatina
<i>Dasus simplex</i>	Tea	Nyeri
<i>Systates</i> sp.	Tea	Nyeri
<i>Lagria hirsuta</i>	Tea	Nyeri
<i>Entypotrachelus micans</i> ..	Tea	Nyeri
<i>Stegobium paniceum</i>	Cayenne pepper	Nairobi
<i>Tragocephala variegata</i> ..	Citrus	Malindi
<i>Aspidomorpha tigrina</i>	<i>Solanum melogena</i> ..	Matuga
<i>Rhina afzelii</i>	Coco-nut palms	Matuga
<i>Ootheca benningeni</i>	<i>Capsicum</i> sp.	Ukunda
<i>Epilachna chrysomelina</i> ..	Cucumber	Matuga
<i>Tetralobus flabellicornis</i> ..	Citrus, Kapok	Ukunda
<i>Oryctes monoceros</i>	Coco-nut palms	General Coast Province
<i>Cylas puncticollis</i>	<i>Ipomoea batatas</i> ..	Matuga
<i>Haltica pyritosa</i>	Rhubarb	Kinangop
<i>Calandra oryzae</i>	Maize	Nairobi, Meru
<i>Oryzaephilus surinamensis</i>	Maize	Nairobi
<i>Tribolium castaneum</i>	Maize	Nairobi
<i>Tenebroides mauritanicus</i>	Maize	Nairobi
<i>Callosobruchus chinensis</i> ..	<i>Dolichos</i> sp.	Kitale
<i>Cosmopolites sordidus</i> ..	Bananas	Nyanza
<i>Leptoglossus membranaceus</i>	Citrus	Matuga

LEPIDOPTERA—

<i>Plutella maculipennis</i>	..	Cauliflowers	..	..	Limuru, Molo, Kerugoya
<i>Laphygma exigua</i>	..	Spinach	..	..	Nairobi
<i>Bedellia somnulentella</i>	..	Ipomoea batatas	..	..	Machakos
<i>Ephestia</i> sp.	..	Maize	..	..	Nairobi
<i>Corcyra cephalonica</i>	..	Maize	..	..	Nairobi
<i>Pontia helice</i>	..	Brassicae	..	..	Machakos
<i>Heliothis armigera</i>	..	Cotton	..	..	Nyanza
<i>Heliothis armigera</i>	..	Tomato fruit	..	..	Machakos
<i>Argyroploce leucotreta</i>	..	Cotton, Oranges,	..	..	Machakos, Matuga,
		Capsicum sp.			Nyanza
<i>Orgyia mixta</i>	..	Apple foliage	..	..	Limuru
<i>Pyrameis cardui</i>	..	Symphytum peregrinum	..	..	Kampi ya Moto, Kitale
<i>Gnorimoschema operculella</i>	..	Potatoes	..	..	Ruiru and Nairobi.
<i>Agrotis segetum</i>	..	Tea nursery	..	..	Kericho
<i>Parasa vivida</i>	..	Coffee	..	..	Nairobi
<i>Argyroploce peltastica</i>	..	Cajanus indicus	..	..	Matuga
<i>Busseola fusca</i>	..	Maize	..	..	Nakuru, Teita Hills
<i>Porthesia producta</i>	..	Ricinus communis	..	..	Matuga
<i>Aegeria</i> sp.	..	Ipomoea batatas	..	..	Matuga
<i>Platyedra gossypiella</i>	..	Cotton	..	..	Nyanza
<i>Earias</i> spp.	..	Cotton	..	..	Nyanza

RHYNCHOTA—

<i>Holopterna alata</i>	..	Citrus	..	..	Ngong
<i>Nezara viridula</i>	..	Ricinus communis	..	..	Machakos
<i>Hilda</i> sp.	..	Grapefruit	..	..	Kabete
<i>Macrosiphum pisi</i>	..	Peas	..	..	Kabete
<i>Planococcus kenyae</i>	..	Strawberry, Passiflora	..	..	Nairobi
		edulis, Custard apple			
<i>Toxoptera citricidus</i>	..	Citrus	..	..	Matuga, Machakos
<i>Orthezia insignis</i>	..	Jacaranda	..	..	Nairobi, Ruiru, Kiambu
<i>Agonoscelis longirostris</i>	..	Maize	..	..	Njoro
<i>Saissetia nigra</i>	..	Ulmus sp. Ficus sp.,	..	..	Nairobi and Kisumu
		Arberia caffra, Avocado			
<i>Trioza merwei</i>	..	Citrus	..	..	Kiambu, Limuru
<i>Diaspis bromeliae</i>	..	Pineapple	..	..	Kikuyu
<i>Chrysomphalus pinnulifer</i>	..	Pansies	..	..	Nairobi
<i>Aulacaspis cinnamomi</i>	..	Mango	..	..	Nairobi
<i>Pericerya purchasi</i>	..	Citrus, roses	..	..	Gilgil, Nairobi
<i>Ferrisia virgata</i>	..	Citrus	..	..	Matuga
<i>Schizaphis graminum</i>	..	Wheat	..	..	Njoro
<i>Rhopalosiphum maidis</i>	..	Oats	..	..	Solai
<i>Coccus hesperidum</i>	..	Pawpaw	..	..	Nairobi
<i>Coccus hesperidum</i>	..	Citrus	..	..	Matuga
<i>Pulvinaria vitis</i>	..	Capsicum sp.	..	..	Teita Hills
<i>Aonidiella aurantii</i>	..	Rosa sp. Citrus	..	..	Kisumu, Kiambu
<i>Eriococcus araucariae</i>	..	Araucaria sp.	..	..	Kiambu
<i>Coccus africanus</i>	..	Gardenia	..	..	Kiambu
<i>Aspidiotus destructor</i>	..	Pawpaw, Gardenia	..	..	Kisumu, Kiambu
<i>Hemiberlesia lataniae</i>	..	Strelitzia	..	..	Kiambu
<i>Pseudaonidia trilobitiformis</i>	..	Citrus fruit	..	..	Kisumu
<i>Dysmicoccus brevipes</i>	..	Maize, Ipomoea batatas	..	..	Kisumu, Ruiru
<i>Icerya seychellarum</i>	..	Mango	..	..	Kisumu
<i>Pulvinaria psidii</i>	..	Coffee	..	..	S. Nyanza
<i>Hilda patruelis</i>	..	Crotalaria sp.	..	..	Nairobi
<i>Planococcus citri</i>	..	Avocado	..	..	Kisumu
<i>Spilococcus perforatus</i>	..	Cotton	..	..	Malindi
<i>Stictococcus</i> sp.	..	Cotton	..	..	Malindi
<i>Ceroplastes vinsonioides</i>	..	Coffee	..	..	Nairobi
<i>Saissetia hemisphaerica</i>	..	Fern	..	..	Nairobi

<i>Saissetia oleae</i>	<i>Cordia holstii</i>	Nairobi
<i>Pseudotheraptus wayi</i> ..	Coco-nuts	Coast Province
<i>Dysdercus supersticiosus</i> ..	Cotton	Nyanza
<i>Dysdercus nigrofasciatus</i>	Cotton	Nyanza
<i>Dysdercus cardinalis</i> ..	Cotton	Nyanza
<i>Aonidimytilus albus</i> ..	Cassava	Kisumu
<i>Lygus vosseleri</i>	Cotton	Nyanza
<i>Akermes andersoni</i> ..	Citrus	Taveta
<i>Chrysomphalus dictyospermi</i>	Mango	Kisumu
<i>Howardia biclavus</i> ..	<i>Cordia holstii</i>	Nairobi
<i>Rhizococcus geniculatus</i> ..	<i>Vernonia</i> sp.	Nairobi

DIPTERA—

<i>Dacus ciliatus ciliatus</i> ..	Gherkins	Molo
<i>Melanagromyza phaseoli</i>	Beans	Naro Moru, Nairobi, Nyeri
<i>Atherigona indica infuscata</i>	Sorghum	Nairobi
<i>Phytomyza atricornis</i> ..	Chrysanthemums ..	Njoro
<i>Hylemyia arambourgi</i> ..	Barley	Njoro, Rongai.
<i>Craspedoxantha marginalis</i>	Zinnias	Kisumu
<i>Ceratitis rosa</i>	Guava	Utange
<i>Ceratitus capitata</i> ..	Capsicum sp.	Matuga
<i>Epimadiza nigra</i>	Gladiolus	Limuru, Nairobi

ORTHOPTERA—

<i>Eugaster loricatus</i> ..	Pineapple fruit	Thika, Machakos
<i>Tapesia grisea</i>	Roses	Embu
<i>Homorocoryphus vicinus</i> ..	Rice	Vanga
<i>Chrotogonus</i> sp.	Vegetables	Kwale, Matuga
<i>Eucerohippus cuncator</i> ..	<i>Chlorophora escelsa</i> seedlings	Kwale
<i>Cyrtacanthacris tartarica</i>	<i>Chlorophora escelsa</i> seedlings	Kwale

ISOPTERA—

<i>Pseudacanthotermes militaris</i>	Sugar cane	Nyanza
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ACARINA—

<i>Aceria sheldoni</i>	Citrus	Matuga, Kabete
<i>Eutetranychus banksi</i> ..	Citrus	Kabete
<i>Aceria</i> sp.	Carnations	Nyeri
<i>Tydeus</i> sp.	Citrus	Matuga
<i>Oligonychus</i> sp.	Cashew	Matuga

INSECT COLLECTION AND COMPILATION OF RECORDS

The reorganization of the collection was continued during the year and this was completed for the most important orders. The collection now begins to assume its proper function as a working collection for the day to day advisory and experimental work. The identification services of the Commonwealth Institute of Entomology have been of great help and are cordially acknowledged. They are essential to the work of the section.

Progress has been made with the pest list of the East African territories.

Insects Identified in 1955 being New Records

Coleoptera

HALTICIDAE—

<i>Phygasia sulcicollis</i> ..	Hibiscus sp.	Thika
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GALERUCIDAE—

<i>Exora kohischitteri</i> ..	<i>Crotalaria</i> sp.	Nairobi
<i>Asbecesta cyanipennis</i>	Beans	Nairobi

HISTERIDAE—

<i>Hister maximus</i>	..	..	Pyrethrum	..	..	Nairobi
<i>Hister latipes</i>	..	..	Wheat	..	..	Ol Kalou

RUTELIDAE—

<i>Anomala graueri</i>	..	..				Kitale
<i>Adoretus dulcis</i>	..	..				Kitale
<i>Adoretus emarginatus</i>	..	..	Roses	..	..	Nairobi
<i>Popillia aeneipennis</i>	..	..	Acacia mollissima	..	..	Limuru

DYNASTIDAE—

<i>Heteronychus sanctae-helenae</i>	..	..	Grass	..	..	Naivasha
<i>Heteronychus amplipennis</i>	..	..	Wheat	..	..	Kinangop
<i>Heteronychus licas</i>	..	..	Maize	..	..	Makuyu
<i>Heteronychus jacki</i>	..	..	Maize	..	..	Muhoroni
<i>Pycnoschema polita</i>	..	..	Maize	..	..	Kitale

CETONIIDAE—

<i>Polyplastus oratus</i>	..	..	Wheat	..	..	Ol Kalou
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HISPIDAE—

<i>Trichispa sericea</i>	..	..	Rice	..	..	Kisumu, Taveta
<i>Diclidispa usambarica</i>	..	..	Digitaria sp.	..	..	Eldoret

Diptera

TRYPETIDAE—

<i>Dacus (Psilodacus) annulatus</i>	..	..	Asclepias curassavica	..	..	Nairobi
<i>Isoconia transilis</i>	..	..	Coffee	..	..	Ruiru
<i>Allotrypes maripilosa</i>	..	..	Coffee	..	..	Ruiru

CALLIPHORIDAE—

<i>Idiella albitarsis</i>	..	..				Kabete
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TACHINIDAE—

<i>Carcelia judicabilis</i>	..	..	Laphygma exempta	..	..	Nairobi
<i>Wagneria carbonaria</i>	..	..	ex cut worm sp.	..	..	Nakuru
<i>Billaea minor</i>	..	..				Narok
<i>Sturmia analis</i>	..	..				Narok
<i>Sturmia (Prosturmia) inconspicua</i>	..	..	Laphygma exempta	..	..	Nairobi
<i>Pales rubrica</i>	..	..				Aberdares

SARCOPHAGIDAE—

<i>Sarcophaga nodosa</i>	..	..	Schistocerca gregaria	..	..	—
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MUSCIDAE—

<i>Dichaetomyia mediocris</i>	..	..				Mt. Kenya Forest
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LONCHAEIDAE—

<i>Lonchaea (Carpolonchaea) laevis</i>	..	..	Tomato fruit	..	..	Machakos
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CHLOROPIDAE—

<i>Scoliophthalmus trapezoides</i>	..	..	Sorghum seedlings	..	..	Shimba Hills
<i>Anomoeocerus hispidus</i>	..	..				Embu
<i>Anomoeocerus punctulatus</i>	..	..				Embu

EPHYDRIDAE—

<i>Notiphila ignobilis</i>	..	..				Kabete
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CHIRONOMIDAE—

<i>Calochironomus oxylabis</i>	..	..				Naivasha
<i>Dictrotendipes speciosus</i>	..	..				Naivasha
<i>Polypedilum alticola</i>	..	..				Laikipia

Hemiptera**APHIDIDAE—**

Brachycaudus helichrysi .. *Passiflora edulis* Nairobi

COCCIDAE—

Hemiberlesia tectonae .. *Calodendron capense* .. Nairobi
Duplaspidiotus tessaratus .. *Grewia* sp. Kisumu
Clavaspis erculeana .. *Erythrina caffra* Nairobi
Odonaspis ruthae .. *Rhynchelytrum repens* .. Nairobi
Saissetia zanzibarensis .. *Mango* Mombasa
Saissetia somereni .. *Flacourtia indica* *Cordia* Nairobi
holstii

Acarina**TETRANYCHIDAE—**

Tetranychus cucurbitae .. *Ricinus communis* .. Nairobi
Tetranychus telarius .. Carrots, tomatoes .. Machakos

PHYTOSEIIDAE—

Iphiseius degenerans .. *Ricinus communis* .. Machakos
Amblyseius caudatus Matuga

TENUIPALPIDAE—

Brevipalpus inornatus .. Strawberry, pansy Machakos,
Njoro

Publications**R. Le Pelley—**

"The Citrus Bud Mite, *Aceria sheldoni* (Ewing) Eriophyidae in Kenya." *E. Afr. agric. J.* XXI:1:July, 1955.

G. De Lotto—

"Three apparently new Coccids (*Homopt.:Coccidea*) from Eritrea," *Jl.ent.Soc.A. Africa*, Vol. 17, pp. 213–218, 3 figs. Pretoria, 1955.

"Three new Coccids (*Hemipt.: Coccoidea*) attacking coffee in East Africa." *Bull.ent.Res.* Vol. 46, pp. 267–273, 3 figs. London, 1955.

J. F. Graham—

"Destruction of Harvester Ants," *Kenya Weekly News* and *K.I.O. Fortnightly*, No. 401. 1.1.56.

Royal Show—Mitchell Park, Nairobi, 1955

The section staged an exhibit at this show, this being prepared under the direction of the Acting Senior Entomologist.

The exhibit was confined to pests of cereals, those in the field being dealt with by the Entomologist, Rift Valley Province, and those of stored products by the Stored Products Inspector. Exhibits included maize stalk borer, black wheat beetle, barley fly and harvester ants; while the importance of winnowing grain. the generation of heat by grain weevils and the use of 0.04 per cent B.H.C. were demonstrated by the Maize Control workers.

Visitors

It has been the practice in the past to include names of some of the visitors to the laboratory. The list of distinguished visitors would now be so lengthy that it is not practicable to include it.

Acknowledgments

I wish to acknowledge the good work of all the European and African members of the section. Assistance is gratefully acknowledged from the Field Staff of the Department. The Commonwealth Institute of Entomology has already been mentioned, the essential help of the Institute is acknowledged with pleasure.

R. LE PELLEY,
Senior Entomologist.

ANNUAL REPORT OF THE SENIOR RESEARCH OFFICER, PLANT PATHOLOGY, 1955

The work of the section during the year was curtailed by the absence on leave during six months of the year of three members of the staff including the officer-in-charge and on account of the Royal Agricultural Show on which occasion a special effort was demanded to publicize the research activities of the Department. An additional commitment was the return of advisory work on cereal diseases from the Senior Research Officer, Plant Breeding, following the departure on leave of the cereal pathologist from the Plant Breeding Station.

The accent on the work of the section tends more and more towards a public service rather than research and investigation. The services consist of general advisory work on such plant diseases as are not dealt with by the commodity specialists and the seed testing and legume inoculant service (*vide infra*) both of which have for some time been on a revenue-earning basis. These services to the public have a priority over such *ad hoc* research projects as may be undertaken from time to time.

During the year 379 specimens of diseased plant material were received, an increase of 40 over the previous year. The diseases represented by those specimens do not differ essentially from those received during the previous year. In connexion with these inquiries 82 persons visited the laboratory.

A serious dwarfing and distortion of indigenous *Trifolium* species including *T. semipilosum*, *T. rueppellianum* and *T. masaiensi* occurred in the Kitale District. When first observed on *T. semipilosum* in experimental plots in 1953 it was considered of little importance but in 1955, however, it had spread to neighbouring plots containing the above species. The general effect of the disease is to cause a dwarfing and weakening of the whole plant and a malformation of the flower heads in which the floret stalks become elongated and bear minute trifoliate leaflets in place of the floral parts. The disease, which is being studied, is possibly of a virus nature. *Uromyces elegans* on *T. semipilosum* was received from the Grassland Research Station. Lucerne and lupins were attacked by *Uromyces striatus* and *U. renovatus* respectively. A disease of *Panicum maximum*, also reported from the Grassland Research Station, Kitale, in which the central shoots are greatly swollen was apparently caused by one of the *Chytridiales* which has not been identified, but is possibly a species of *Cladochytrium*. A severe heart rot of fodder beet was caused by *Rhizoctonia solani*. Blind seed disease of perennial rye grass, *Phialea temulenta*, has not been recorded in Kenya. Quantities of seed required to be imported could not be certified as free from this disease. Seed has, nevertheless, been admitted to satisfy an increasing demand for the establishment of this crop. It is considered that even were the disease to become established it would not affect the production of fodder or grass cover. Perennial rye grass was also severely attacked by *Puccinia coronata*. Difficulty in establishing lucerne from seed near Lake Naivasha was attributed to unfavourable soil conditions rather than to any pathogen. Leaf lesions on Russian comfrey, *Symphytum peregrinum*, were received from a number of localities. No pathogens could be demonstrated in the leaves. It is thought that the symptoms were possibly induced by insect attack at the roots. A number of specimens of grass species were sent in with *Sphacelia*, *Cerebella* and *Fusarium heterosporium*. *Phyllachora* spp. occurred on a number of grasses. A severe outbreak of *Peronospora parasitica* associated with *Cystopus candidus* occurred on kale being grown for seed.

Septoria lycopersici on tomatoes was recorded on many occasions and was frequently sent in as blight, *Phytophthora infestans*, which disease caused considerable damage in many localities. The bacterial wilt of tomatoes, *Pseudomonas solanacearum* and "leaf spot" caused by *Alternaria solani* were among the diseases received. Diseases of french beans included halo blight, *Pseudomonas medicaginis* f. *phaseolicola*, the most commonly occurring, *Ascochyta phaseolorum* and rust *Uromyces phaseolorum*. *Dolichos lab-lab* and cowpea were again attacked by *Elsinæ phaseoli* which fungus was also present on green gram, *Phaseolus aureus*. A suspected case of *Pseudomonas pisi* was disproved; so far this disease has not appeared in Kenya, but is regularly tested for in consignments from abroad. The bacterial disease affecting the bud scales of the globe artichoke, *Cynara scolymus*, reported for the first time in 1954, was not reported again. A severe case of asparagus rust, *Puccinia asparagi*, occurred on the variety Martha Washington which is claimed to be immune or highly resistant. Cabbages were in one or two localities attacked by *Xanthomonas campestris*. Chillies in both the Coast and Central Provinces suffered severely from one or other or a combination of the following fungi, *Leveillula taurica* (Lev.) Arnaud, *Cercospora unanunoi*, *Castellani* and *Colletotrichum capsici*. The two former were at times so severe as to cause total defoliation and the last, black lesions on the pods or a total black discoloration which frequently developed only during drying. A commonly occurring die-back followed attacks of this fungus and defoliation by *Leveillula taurica*. A crop of groundnuts in the Coast Province suffered severe defoliation on account of *Cercospora personata*. Since defoliation occurred after the development of the seed the yield was little affected.

Stem-pitting disease of citrus was confirmed in the Coast Province. At the Coast Horticultural Station, Jaffa oranges showed symptoms suggestive of psorosis, but it is considered that the age of the trees and the source of the bud wood are against the psorosis virus being the cause; confirmatory evidence is being sought. Stem-pitting virus was apparently present in a number of trees at the station. Some concern was caused by the suggestion from the Kenya National Farmers' Union that Kenya should follow the action of the Rhodesian Union in demanding the prohibition of all citrus imports from South Africa on account of the danger of introducing black spot, *Phoma citricarpa*, not so far recorded in Kenya. I was able to discuss this problem with Dr. Wager in Durban. It seemed that as the latent stage of the disease was almost certainly present or had in the past been introduced from South Africa the imposition of any restrictions were unnecessary. An occasional instance of Panama disease of bananas, *Fusarium oxysporum* v. *cubense*, was received for identification, but the disease does not appear to be on the increase.

Few diseases were received on deciduous fruits. Rust, *Puccinia pruni-spinosæ*, crown gall and root rot, *Armillaria mellea*, occurred on peach, and mildew, *Podosphæra leucotricha*, scab, *Venturia inaequalis*, and virus mosaic on apple. Virus diseases of strawberries at the Molo Horticultural Experimental Station have been studied by Dr. Storey who diagnosed the strawberry "crinkle" virus complex on established and recently imported stocks. In view of the apparent widespread infection of stocks throughout the country the question of insisting on certification of imported stocks is under review.

The incidence of bud disease of pyrethrum, *Ramularia bellunensis*, has showed no increase and appears now to have reached a state of equilibrium. Experimental samples of "Actidioni", "Griseofulvin" and "Phyto-mycin" were kindly supplied by the manufacturers for trial against this disease. It is thought that, unlike more conventional sprays, control by means of these antibiotic fungicides might prove economic. The bud disease reported in 1954 caused by a

species of *Ascochyta* has not reappeared. *Rhizoctonia solani* was associated with root and crown rot from various localities. A clone resistant to *Ramularia bellunensis* has been received from the Belgian Congo and is under trial at the Scott Laboratory.

Rust of antirrhinums, *Puccinia antirrhini*, first recorded in 1954, was again serious in 1955 and caused considerable loss to commercial growers. A stem rot of the same host caused by *Phyllosticta antirrhini* was also received. Rust of carnations, *Uromyces dianthi*, was again serious both to private and commercial growers. Dahlia leaf spot, *Entyloma dahliae*, was generally widespread. A species of *Ramularia* was found causing a leaf spot of pansies. A soft rot of *Zantedeschia rhizomes* was caused by bacteria, probably the *Bacterium carotovorum*. A disease of *Gladiolus* affecting the basal two or three inches, but leaving the corm undamaged occurred in a commercial nursery was caused by a species of *Botrytis*. The effect was to destroy the soft tissue between the vascular bundles. Few sclerotia were formed and no conidial stage seen in the field: *Botrytis*, however, developed in culture and was probably a form of *B. cinerea*. An extensive corm rot from another district yielded *Fusarium oxysporum* in culture.

Blight-resistant Potatoes

Trials of blight-resistant potatoes supplied by Dr. W. Black have continued as in previous years. The aim is now to reduce the numbers to a few outstanding varieties. During the past season a number have been discarded as being unlikely to yield satisfactorily under Kenya conditions. Four varieties of Dr. Black's hybrids are now being bulked and will be available for distribution in 1956. These are as follows:—

Dr. Black's No.	Scott Laboratory	Genotype	Race Susceptible
1664 a (12)	E/52	R1R2	G
1812 a (8)	K/52	R3R4	I
1521 d (24)	C/53	R1R2R3	Hypothetical
1943 de (1)	J/53	R1R2	G

Race (G) has been recorded in Kenya, but neither E/52 nor J/53 has been attacked. Race I was identified early in the year but has not been identified on potatoes. The blight occurred on tomatoes, seed of which was obtained from Dr. Black in 1954 with the description of D.M.M. The blight was inoculated into small tubers of Arran Pilot and identified by Dr. Black as race 34 (I). The D.M.M. tomatoes were expected to segregate and show varying degrees of resistance. The selection of these is being continued.

During the year some of the blight-resistant potatoes have been grown experimentally by farmers in different localities and at a number of departmental experimental stations. A small consignment of E/52 and K/52 were sent to the Uganda Department of Agriculture. The biotypes of blight so far determined in Kenya are A, C, D, G, H and I. Stock seed (SS) of the following varieties were imported for trial from the United Kingdom:—Record, Ulster Dale, Craig's Alliance, Ulster Emblem, Chancellor Pentland Ace and Orion. This seed was planted at the East African Agriculture and Forestry Research Organization nursery at Muguga and cared for by the Horticulturist, Mr. W. B. May, to whom grateful thanks are due. It was considered that the chances of virus disease infection were less at Muguga than at the Scott Laboratory. It is hoped that by keeping them at a high altitude and on an exposed site that serious degeneration will be deferred long enough to enable multiplication and distribution to take place on a commercial scale. During growth, these potatoes were sprayed with insecticide.

Legume Inoculants

Individual orders for inoculants totalled 308, an increase of 77 over 1954. The number of units of inoculum, each sufficient to inoculate 20 lb. of small or 40 lb. of large seed, issued was 2,804 and was proportioned as follows:—lupin, 1,289; lucerne, 499; pigeon pea (*Cajanus*), 159; garden pea, 127; dolichos, 75; clovers, 148; serradella, 104; soya beans, 44; sunnhemp (*Crotalaria*), 73; vetches, 69; beans (*Phaseolus*), 26; velvet bean (*Stizolobium*), 60; cowpea, 28; and miscellaneous 103. Lucerne dropped from 703 in 1954 to 499 in 1955, while lupins and clovers rose from 333 and 78 to 1,289 and 148 respectively.

As in the past, close co-operation was maintained with the Pasture Research Team and much of the work of this side of the section's activities has been the production of strains of *Rhizobia* suited to the various legumes which are being studied at the Grassland Research Station. The most useful strain obtained locally is that for the nodulation of *Trifolium semipilosum*; a locally esteemed clover which appears to nodulate best with its own strain. A strain was selected after comparative tests from nine isolations from different localities. Much of the routine work during the year has been isolation and testing of new strains from various sources and the maintenance of purity of the stock and of the effectiveness of nitrogen fixation. Considerable improvements in technique have been introduced during the year. It is found that the best and most consistent results are obtained from the sterile tube culture and a nitrogen-free medium. Sand, as a rooting medium has proved superior to sand and vermiculite mixtures and to pure vermiculite.

The series of experiments started in 1954 to investigate the reasons for occasional failure of legumes to form nodules at the Grassland Research Station, Kitale, was continued.

Soil from this station was tested for various adverse factors including low pH, lack of phosphate, competition with naturally occurring, ineffective strains, nutritional factors in general, soil physical factors and bacteriophage. In a detailed experiment based on the standard test method it was found that effective nodules formed in all treatment combinations which included *Rhizobia* and all the above factors had to be ruled out as possible causes of failure of nodule formation.

An experiment to measure the amount of atmospheric nitrogen fixed by nodules of *Trifolium semipilosum* growing in Kitale soil with various corrections was started. Results of this experiment will not be available until 1956.

Seed-testing Laboratory

There has been a considerable increase in the number of tests, a total of 1,593 being undertaken during the year as against 907 the year before. The samples sent for testing consisted of cereals, 567 (36 per cent); vegetables, 382 (22 per cent); grasses, 304 (19 per cent); ornamentals, 199 (12 per cent); legumes, 67 (4 per cent); and other crops, 76 (5 per cent). Of the tests of grass seeds 60 were on *Setaria* spp. and *Chloris gayana* (Rhodes grass) samples in connexion with fertilizer experiments at the Grassland Research Station, Kitale.

Germination of cereals was generally better this year than last. There is still, however, a tendency for growers to send seed in for testing directly after harvest and before the dormancy period is over. It is believed that excessive moisture content of the seed at harvesting lengthens the dormancy period. Such an excess occurs mostly in seed which has been combine harvested. It has again been shown that barley will not germinate satisfactorily on sand until the end of the dormancy period. It has been known for some time that this difficulty can be

overcome, at least in part, by germinating the immature barley on unsterilized soil instead of on sand. A series of experiments is now in progress with seven varieties of barley supplied by the Plant Breeding Station at Njoro to compare the effects of these soil and said treatments on freshly harvested barley. It is hoped to discover the length of the dormancy period and the correlation, if any, between the germination of dormant barley on soil and the germination of the same seed on sand once the dormancy period is over. This series of experiments will continue for most of 1956. Abnormal seedlings in cereal tests resulted from the use of certain proprietary brands of organo-mercurial and insecticidal seed dressings.

The germination of certain vegetable seeds imported from Europe showed a marked depression as the result of the voyage to Kenya, and delay at the coast. It was found, however, that a considerable improvement in the germination, some cases approximating that of the pre-export figure, occurred after storage for about a month at Nairobi (5,700 ft.). Beet seed with a pre-export germination of 82 per cent and 90 per cent was raised from 23 per cent to 91 per cent and from 38 per cent to 88 per cent respectively after storage in Nairobi for two months, washing in running water for two hours and germination on unsterilized soil after treatment with an organo-mercurial seed dressing. The factors concerned are subjects for investigation. Other seed from abroad showing similar depressed germination were sage, chillies and spinach.

In general, the samples of Rhodes and molasses grass showed a slightly higher germination than over previous years. There is some difficulty in judging the time to harvest these grasses as the flower heads do not ripen uniformly. The indigenous Nandi strain of *Setaria* sent for testing by the Grassland Research Station also appears to have undergone an improvement in germination in the last few years, although the figure for purity remains low.

Of the seeds of ornamentals received for testing, Broom hybrids and *Clianthus dampieri* (the Glory pea of Australia) were found to need hot water treatment before they would germinate satisfactorily. This treatment consists of plunging the seed into boiling water (water boils at 95° C. in Nairobi) and leaving them in the water until it is cool. This treatment was found to be nearly as effective as treatment with sulphuric acid. Canna seeds required scarifying before they would germinate in a reasonable time.

Two samples of lucerne, one from France and one believed to have originated in Australia, were found to contain seed of *Medicago lupulina*. Although *M. lupulina* is a common impurity in lucerne, it has not previously been found in seed imported into Kenya or in locally produced seed.

Some experiments to test the effect of scarifying on indigenous legume seeds were done on behalf of the Grassland Research Station, Kitale. In all cases the scarified seed had an improved germination varying with the screens used. The scarifying was done at the Grassland Research Station.

Seeds not previously tested in this laboratory were *Malpighia punicifolia* (the "Acerola Cherry") obtained from Puerto Rico and the Department of Agriculture, Jamaica, for trials in Kenya, and the flamboyant *Poinciana regia*. A herbarium sample of *Urena lobata* seed was sent to Madingou in French Equatorial Africa at the request of the Director of Institut de Recherches du Cotton et des Textiles Exotique in Paris. A number of new seeds were added to the seed collection, which is being built up for the identification of samples, and 18 new specimens were added to the herbarium. The assistance of the East African Herbarium in naming some of the 27 plants sent to the seed laboratory for identification is gratefully acknowledged.

An exhibit illustrating various aspects of seed testing and its value to the agricultural industry was staged at the Royal Agricultural Show. The testing of seeds of various cereals, grasses, clovers and vegetables was demonstrated and a collection of common injurious and other weed seeds found in seed samples shown. All exhibitors of crop seed at the Show were required to produce purity and germination certificates issued by the Seed Testing Laboratory.

None of the samples received for testing during the year showed serious fungal or bacterial infection with the exception of some samples of vegetable seed kept too long in storage. The wet harvesting period was reflected in 85 per cent of wheat samples with varying degree of "Black Point" which yielded the usual species of *Epicoccum*, *Alternaria*, *Cladosporium* and *Helminthosporium sativum*. On one sample the "Black Point" effect was produced by the teleuto stage of *Puccinia graminis*. No instance occurred of *Helminthosporium tritici-repentis*. Imported peas gave negative results when tested for *Pseudomonas pisi*.

There have been many visitors to the laboratory during the year, those from outside Kenya came from Uganda, Rhodesia, France and the United States.

Royal Show

Three stands were prepared to illustrate the work of the three main activities of the section. The plant pathological stand was centred on a chart summarizing the principles of plant disease control and the exhibits were designed to illustrate these principles. A wide variety of protective and so-called systemic fungicides with descriptions of eradivative and roguing methods illustrated "Combat of the Pathogen". "Aid to Host" was illustrated by breeding for resistance and immunity, the main exhibit being some blight-resistant potatoes. "Barriers to Prevent the Pathogen Reaching the Host" showed, by means of pictures and specimens, how international, regional and local quarantine measures can prevent the spread of new diseases. Cultural methods of disease control such as rotation, ring-barking of bush plants, soil sterilization, etc., were also included in this section. The legume inoculant stand emphasized the service that was available to the public and the nature and function of legume inoculants. Inoculated and uninoculated plants, shown side by side with clearly visible differences in growth, attracted appreciative comment. The seed testing stand was a replica of the entire seed testing process with a chart showing how and why the final analysis was obtained and emphasizing that such things as injurious weed seeds, etc., are as important as the percentage germination. A large, highly polished, Boerner sampler was a source of continual attraction.

R. M. NATTRASS,
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ANNUAL REPORT OF THE SOIL CHEMIST, 1955

Fertilizers and Fertilizer Study

A programme of fertilizer trials was continued and with the posting in the second half of the year of officers in the field and at Headquarters specifically to carry out fertilizer experiments in African areas, and of additional general investigation staff to Agricultural Research Stations in European areas, it has been possible to put plans in train for an intensification of the effort.

The 2³NPK exploratory fertilizer trials which were attempted in 1954, on soils of Coast Province derived from Magarini sands were repeated on nearby sites in 1955. The sorghum crop this year was carried through to maturity at five of the six sites investigated. Though yield levels and responses varied greatly from site to site, general phosphate and frequent nitrogen but no potash responses were recorded, the average N and P effects over all five sites being:—

YIELD OF SORGHUM LB./ACRE
Double Supers
cwt./acre

	0	1	Mean
Sulphate of ammonia 0	487	715	601
cwt./acre 1	614	974	794
Mean	550	845	695
Least difference for significance			
between means:			
5 per cent	103		
1 per cent	139		

From the application of 1 cwt. of sulphate of ammonia 193 lb. more grain/acre were obtained, and 295 lb. more grain/acre from the application of 1 cwt. double supers/acre. The possibilities of appreciable profit being obtained from phosphate application promises to be widespread from soils derived from Magarini sands. On the other hand, the use of sulphate of ammonia on these soils promises to show profit under more restricted conditions and further trials will be needed to establish these conditions.

The results of the 1954 exploratory fertilizer trials in Central and Rift Valley Provinces, African areas, were less certain but justify continuation of investigation. A proportion of the Central Province trials suffered at the hands of *Mau Mau* gangs and of the Rift Valley trials through stock damage.

The complementary rates trials were continued on an expanded scale so that the following information additional to that tabulated in the 1954 Report can now be presented:—

Centre Altitude and Soil	Season and Rainfall during growth Yield units	Crop Fertilizer Treatment	Level	YIELD DATA: FERTILIZER		
				N	P	K
Kibarani 50 ft. Freely drained slightly acid sand of low fertility derived from lag- oonal sands.	L.R. 1952. lb. grain/acre.	Dwarf Hegari Sorghum N, P and K applied.	0	1226	1133	1165
			1	1032	1240	1107
			2	1204	1089	1191

Centre Altitude and Soil	Season and Rainfall during growth Yield units	Crop Fertilizer Treatment	Level	YIELD DATA: FERTILIZER		
				N	P	K
	S.R. 1952.	Cowpeas	The crop proved an unsatisfactory test crop, flowering and seed setting being suppressed where vegetative growth was good.			
	L.R. 1953. lb. grain/acre.	Dwarf Hegari Sorghum on new site. N, P and K applied.	0	1267	1318	1238
			1	1467	1373	1380
			2	1526	1605	1678*
	S.R. 1953. lb. grain/acre.	Green gram Residual	0	312	299	308
			1	298	283	297
			2	304	332	310
	L.R. 1954. 10.56 in. lb. grain/acre.	Dwarf Hegari Sorghum N, P and K reapplied.	0	1494	1639	1680
			1	1917*	1807	1791
			2	2065**	2031	2005
	S.R. 1954. Rains failed.	No crop taken				
	L.R. 1955. 20.08 in. lb. grain/acre.	Dwarf Hegari Sorghum N, P and K reapplied.	0	166	385	433
			1	536*	485	446
			2	738**	571	561
Matuga 400 ft. Freely drained acid sand of low fertility de- rived from Magarini sands.	To S.R. 1954, <i>see</i> Annual Report, 1954					
	L.R. 1955. cwt. wilted Fodder/acre total of 2 cuts.	Guinea grass planted L.R. 1954. P reapplied early in rains N and K re- applied early in rains and again after first cut.	0	77.8	73.5	88.7
			1	84.3	87.2*	89.7
			2	103.2*	104.6**	86.8
Shimba Hills 800 ft. Pallid acid sand of low fertility.	L.R. 1952. lb. grain/acre.	Dwarf Hegari Sorghum N, P and K applied.	0	2200	1254	2643
			1	2613	3158**	2542
			2	2938*	3338**	2565
	S.R. 1952. lb. grain/acre.	Cow pea Residual	0	124	69	74
			1	121	158	132
			2	114	132	153
	cwt. haulms/ acre.	Results not analysed.	0	28.3	11.1	29.1
			1	26.2	32.0**	31.2
			2	27.8	39.2**	33.0
			The crop proved an unsatisfactory test crop, flowering and seed setting being suppressed where vegetative growth was good.			

Centre Altitude and Soil	Season and Rainfall during growth Yield units	Crop Fertilizer Treatment	Level	YIELD DATA: FERTILIZER			
				N	P	K	
	L.R. 1953. lb. grain/acre.	Dwarf Hegari Sorghum N and K re- applied.	0 1 2	500 593 566	526 659 474	553 533 573	
	lb. straw/acre.		0 1 2	2793 3367 3187	2893 3333 3410	2867 2960 3340	
	Grain and straw results not analysed.						
	S.R. 1953. lb. grain/acre.	Green gram Residual	0 1 2	524 538 578	518 571 551	536 567 538	
	Site abandoned.						
	L.R. 1955. lb. grain/acre.	Dwarf Hegari Sorghum on new site. N, P and K applied.	0 1 2	777 888 978	177 1166** 1301**	816 824 1002	
	Nil P plots suffered heavily from insect damage.						
	Embu 4,800 ft. Kikuyu dark red loam.	To S.R. 1954, see Annual Report 1954.					
		L.R. 1955. lb. grain/acre.	Maize N reapplied at double rate, half to seed bed and half topdressed.	0 1 2	2523 3212* 3143*	2562 2847 3468**	3236 2743 2899
	Kampi ya Mawe 3,700 ft. red Plains soil.	To L.R. 1954, see Annual Report 1954.					
		S.R. 1954. 14.77 in. lb. grain/acre.	Dwarf Hegari Sorghum N and K re- applied.	0 1 2	1172 1216 1203	1019 1244* 1328**	1290 1157 1144
		L.R. 1955. 6.45 in. lb. grain/acre.	Bulrush millet N and K re- applied	0 1 2	559 576 573	496 549 664**	567 588 556
Makaveti 4,900 ft. Makaveti red loam.	To L.R. 1954, see Annual Report 1954.						
	S.R. 1954. lb. grain/acre.	Bulrush millet	0 1 2	458 485 419	367 472* 524**	446 464 453	
	L.R. 1955. lb. stover/acre	Muratha maize N reapplied	0 1 2	996 836 791	818 818 987	921 809 892	
	Crop droughted and failed so stover weights only taken.						

Centre Altitude and Soil	Season and Rainfall during growth Yield units	Crop Fertilizer Treatment	Level	YIELD DATA: FERTILIZER		
				N	P	K
Bungoma 4,700 ft. Red sandy loam.	L.R. 1952. lb. grain/acre.	Maize N and P applied	0	3042	2358	—
			1	3068	3290	—
			2	3572	3632	—
			3	3644	4046	—
			Results not analysed.			
	L.R. 1953.	Rose Coco beans Residual	0	—	94.5	—
			1	—	129.8	—
			2	—	217.2**	—
			3	—	238.1**	—
			No significant residual nitrogen effects.			
	L.R. 1954. 36.83 in. lb. grain/acre.	Maize Residual	0	—	1320	—
			1	—	1590	—
			2	—	1798*	—
			3	—	1960*	—
			No significant residual nitrogen effects.			

NOTES—

- (1) No interactions of significance were observed in any of these trials.
- (2) Yields marked * are significantly different from the corresponding nil level yield at the 5 per cent point.
- (3) Yields marked ** are significantly different from the corresponding nil level yield at the 1 per cent point.
- (4) At Bungoma the rates of sulphate of ammonia and double supers corresponding with levels 0, 1, 2 and 3 were 0, 0.24, 0.48 and 0.72 cwt./acre respectively. In all other trials, except where otherwise specified, at each time of application nitrogen was applied as sulphate of ammonia at 0, 1 and 2 cwts., phosphates as double supers at 0, 1 and 2 cwt., and potash as muriate of potash at 0, $\frac{1}{2}$ and 1 cwt./acre, these rates of application corresponding with the 0, 1 and 2 levels of each described in the Table.

The relative infrequency and unpredictability of N and K responses are again noteworthy. The Embu results are of particular interest in this connexion for 1955 is the first year in which a clear-cut N response has been obtained there and in this year for the first time a sulphate of ammonia application was given to the seed bed. Doughty (*E. Afr. agric J.*, XIX, 1953, 30-31) and Holme and Sherwood (*Highland Fertilizer Scheme Report*), found that within broad limits, time of nitrogen application to maize was of minor importance in areas where nitrogen responses are great. The Embu result suggests that in areas where N responses are less clear, time of N application is well worth investigating.

On soils which respond strongly to phosphate, it becomes apparent that significant effects can be expected to persist for at least four or five seasons after application of 1 or 2 cwt./acre double supers. The persistence of such residuals widens the possibilities for intensification of production through the use of phosphatic fertilizers for not only can the profit be counted over a number of years, but also application of the fertilizer in an unresponsive season need not be counted a complete loss and under these conditions returns can be anticipated in future more favourable seasons. At no centre has clear-cut evidence been obtained that on the crops tested, complementary application of N and P is necessary for securing the best response from either.

At centres where highly significant phosphate responses have been recorded, the possibility of securing economy in phosphate usage through the association of double supers application with FYM dressings has been under investigation. At these centres residual and reapplication effects have also been studied. The following table summarizes the results obtained from those trials, for which three years' accumulated results are available:—

Season Rainfall during growth. Yield units	Crop and Fertilizer Treatment	Level	Ma	Pa	Mb	Pb
Matuga 400 ft. deep acid grey sandy soil of low fertility derived from Magarini sands.						
L.R. 1953. lb. grain/acre.	Dwarf	0	456	426	—	—
	Hegari	1	504	451	—	—
	Sorghum	2	—	618*	—	—
	Ma and Pa applied	4	534	—	—	—
S.R. 1953. 17.92 in. lb. grain/acre.	Green Gram	0	72.2	57.6	—	—
	Residual	1	64.9	72.6*	—	—
		2	—	80.0**	—	—
		4	72.8	—	—	—
	lb. haulms/acre	0	209	167	—	—
		1	186	207	—	—
		2	—	216	—	—
		4	195	—	—	—
	haulm results not analysed.					
L.R. 1954. 6.33 in. lb. grain/acre	Green Gram	0	68.0	57.8	—	52.5
	Pb applied	1	64.0	76.5**	—	69.3*
		2	—	60.5	—	72.8**
		4	62.8	—	—	—
	lb. haulms/acre	0	628	512	—	521
		1	552	661	—	629
		2	—	594	—	618
		4	588	—	—	—
	haulm results not analysed.					
S.R. 1954. 6.36 in. lb. grain/acre	Dwarf	0	521	480	—	505
	Hegari	1	571	545**	—	561
	Sorghum	2	—	671**	—	631**
	Residual	4	605**	—	—	—
L.R. 1955. 28.57 in. lb. grain/acre	Dwarf	0	763	722	—	671
	Hegari	1	605	837	—	749
	Sorghum	2	—	502**	—	641
	Residual	4	693	—	—	—
Kakamega 5,200 ft. deep red loam						
L.R. 1953. 48.74 in. lb. grain/acre	Maize	0	3094	3270	—	—
	Ma and Pa applied	1	3420*	3454	—	—
		2	—	3184	—	—
		4	3394*	—	—	—
L.R. 1954. 53.22 in. lb. grain/acre	Maize	0	3356	3452	—	—
	Residual	1	3512	3404	—	—
		2	—	3378	—	—
		4	3364	—	—	—
L.R. 1955. 71.35 in. lb. grain/acre	Maize	0	2252	2360	—	—
	Residual	1	2636	2740	—	—
		2	—	2606	—	—
		4	2790**	—	—	—
Kisii 5,600 ft. deep red loam						
L.R. 1953. 38/64 in. lb. grain/acre	Sorghum	0	1656	1812	—	—
	Ma and Pa applied	1	1672	1916	—	—
		2	—	2004	—	—
		4	2192**	—	—	—
S.R. 1953. 27.72 in.	Sorghum	0	350	414	—	—
	Residual	1	388	352	—	—
	Ratoon	2	—	—	—	—
		4	495**	—	—	—
L.R. 1954. 40.86 in. lb. grain/acre	Finger Millet	0	978	992	924	924
	Mb and Pb applied	1	1128	1012	—	1264
	Ma and Pa	2	—	1184	1000	—
	Residual	4	1080	—	—	—

Season Rainfall during growth. Yield units	Crop and Fertilizer Treatment	Level	Ma	Pa	Mb	Pb
L.R. 1955. 54.05 in. lb. grain/acre	Maize	0	2654	2656	2682	2682
	Ma and Pa reapplied	1	2692	2772	—	2812
	Mb and Pb	2	—	2852	2784	—
	Residual	4	2934	—	—	—

NOTES—

- (1) Yields marked * are significantly different from the corresponding nil level yield at the 5 per cent point.
- (2) Yields marked ** are significantly different from the corresponding nil level yield at the 1 per cent point.
- (3) M was applied as FYM at 0, 2½, 5 and 10 tons/acre, these rates being signified by the level 0, 1, 2 and 4.
- (4) P was applied as double supers at 0, ½ and 1 cwt./acre, these rates being signified by the level 0, 1 and 2 in the Table.
- (5) The suffixes "a" and "b" refer to the year of application.

These trials were intended to be in elaboration, in phosphate responding areas, of the rates of fertilizer application trials and to be undertaken on the same kinds of soil as those on which phosphate responses had been established. However, local factors which influenced the selection of sites for the trials led to them being situated occasionally on somewhat different kinds of soil from the soil of the parent trial sites. Nevertheless, where comparisons are possible, the phosphate response pattern in the two trial groups are similar and mutually confirmatory.

No consistent effect on the economy of phosphate or of FYM usage was observed either in the season of application or later by their use in association with one another rather than independently. If anything, however, slightly less benefit was obtained when the two were used together than when they were used separately. On the acid phosphate responding sands of low fertility of Coast Province there are indications that the residuals of double supers applied in one year reduce the effectiveness of double supers application in the succeeding year, the interaction becoming stronger as the rate of application of the initial dressing increases. The optimum frequency of phosphate application on such soils clearly needs investigation.

In other phosphate responding areas new comparisons have been made of the effectiveness of different phosphatic fertilizers likely to be of interest to the farming community there. In such trials an attempt was made to express the value of single supers, soda phosphate, basic slag and North African rock phosphate in terms of "double supers equivalence", following a technique developed by Crowther, Warren and Cooke (*The Agricultural Value of Alternative Phosphatic Fertilizers other than Silico Phosphate*, Part II. Field Experiments. Permanent Records of Research and Development, No. 11,109, Ministry of Supply, London, 1953). Rates of application were based on 33 lb. and 66 lb. citric soluble P_2O_5 /acre as double supers, 66 lb. as single supers and 50 lb. in the case of each of the other fertilizers. Trials were carried through to harvest on wheat on Kinangop silt loam and on young grass on Kitale sandy loam. The results obtained are summarized:—

Centre and Crop	No Phosphate	33 lb. Double Supers	66 Citric Soluble P_2O_5 /acre as:					50 Soda Phosphate	Rock Phosphate
			Double Supers	Single Supers	Basic Slag				
KINANGOP: Wheat lb. grain/acre	336	647***	768***	774***	700***	594**	434		
Double supers equivalence	—	—	—	221	295	504	2240		
KITALE: Grass tons green matter/acre—									
First cut 15-17/9 ..	4.3	11.1	11.2	11.1	8.1	9.4	7.1		
Second cut 10/11 ..	5.5	2.5	2.8	2.1	5.0	3.6	4.9		
Third cut 11/1/56 ..	5.1	7.4	7.6	8.0	8.8*	6.8	5.6		
Total for year	14.9	21.0	21.6	21.2	21.9	19.8	17.6		
Double supers equivalence at establishment	—	—	—	503	4061	2377	8190		
Over first year	—	—	—	432	less than 306	681	2190		

NOTES—

- (1) Yields marked * are significantly different from the corresponding "no phosphate" yield at the 5 per cent point.
- (2) Yields marked ** are significantly different from the corresponding "no phosphate" yield at the 1 per cent point.
- (3) Yields marked *** are significantly different from the corresponding "no phosphate" yield at the 0.1 per cent point.
- (4) The "double supers equivalence" of each fertilizer is the number of lb. of that fertilizer which by calculation needs to be applied to produce the same effect as 100 lb. of 42 per cent double supers.
- (5) The "double supers equivalence" data for the wheat trial is calculated on the Mitscherlich response equation $r=509 (1-10^{-0.0123x})$ where r is the response and x is the citric soluble P_2O_5 application, both in lb./acre, which fits the double supers response data.
- (6) The "double supers equivalence" data for the establishment cut is calculated on the Mitscherlich response equation $r=6.90 (1-10^{-0.055x})$ where r is the response in tons and x the citric soluble P_2O_5 application in lb./acre.
- (7) Owing to the flatness of the double supers response curve in the 33-66 lb./acre P_2O_5 application range, the "double supers equivalence" data for the establishment cut is very approximate only.
- (8) The "double supers equivalence" data for the year's total grass clipping is calculated on the Mitscherlich response equation $r=6.77 (1-10^{-0.030x})$ where r is the response in tons and x is the citric soluble P_2O_5 application in lb./acre.

In neither trial did the citric soluble P_2O_5 content of the fertilizers used provide a direct measure of their effectiveness. In consequence, while the citric soluble P_2O_5 content may well be a satisfactory means of determining the quality of a given sample of fertilizer in comparison with other samples of similar type, patently it is a much less effective basis of comparison of phosphatic fertilizers of different types. The influence of particle size on the effectiveness of the citric soluble P_2O_5 content of Seychelles phosphate was discussed in the 1951 Chemistry Section Annual Report and in that, a somewhat similar conclusion was reached.

The effects of the superphosphates, soda phosphate and rock phosphate in the grass trial, all were confined to the first cut. On the other hand, an appreciably longer term of effectiveness, reaching significance in the third cut, was apparent from the use of basic slag.

Other comparisons of phosphatic fertilizers and other studies of the accumulative effects of repeated phosphate application and phosphate residuals are in train.

Lime—Fertilizer Experiments

The four experiments laid down in 1953 and 1954 were continued during 1955. At all centres the N, P and K treatments were reapplied at the initial rates. (P_0 = nil, P_1 = 100 lb., P_2 = 200 lb., P_3 = 400 lb. double superphosphate. K_0 = nil, K_1 = 200 lb. muriate of potash. N_0 = nil, N_1 = 200 lb. ammonium sulphate per acre.)

(1) *Kaptagat*.—Lime applied April, 1953. Rates: L_0 = nil, L_1 = 4,600 lb., L_2 = 10,206 lb., L_3 = 18,000 lb. dolomite limestone. M = 16,000 lb. calcitic limestone. H = 9,300 lb. lime whitewash per acre.

The straw from the 1954 crop was ploughed in on a plot basis.

Effect on Soil pH. 0–8 in. 1:1 soil water ratio. Mean values:

			L_0	L_1	L_2	L_3	M	H
January, 1955	..	..	4.85	5.07	5.48	5.93	5.92	5.37
January, 1956	..	..	4.85	5.12	5.65	6.29	5.99	5.37

The lime applications especially at the heaviest rate were still producing an effect during 1955. Neither phosphate nor potash had any effect on soil pH. Ammonium sulphate appears to have had a slight depressing effect.

			N_0	N_1
January, 1955	..	..	5.46	5.41
January, 1956	..	..	5.60	5.48

Samples of sub-soil (8–16 in.) were taken from three plots of each of the treatments L_0 , L_3 and M in January, 1956. Mean values are:—

L_0	L_3	M
4.91	5.23	5.16

There is an indication that lime is now having a slight effect on the sub-soil.

The wheat crop was harvested in December, 1955. Owing to the severe lodging of the Sabanero variety on the high phosphate (P_2 and P_3) plots in 1954, the variety 341 was planted in 1955. The growth of 341 on the control plots was so poor that these plots could not be harvested.

(2) *Eldoret*.—Lime applied May, 1953. Rates: L_0 = nil, L_1 = 6,860 lb., L_2 = 11,000 lb. dolomite limestone. M = 6,150 lb. calcitic limestone per acre.

The straw from the 1954 harvest was ploughed in on a plot basis.

Effect on Soil pH. 0–8 in.

			L_0	L_1	L_2	M
January, 1956	..	..	5.06	5.89	6.31	5.98
			P_0	P_1	P_2	
January, 1956	..	..	5.74	5.84	5.84	
			N_0K_0	N_0K_1	N_1K_1	
January, 1956	..	..	5.89	5.82	5.72	

Superphosphate appears to have brought about a slight increase in pH and both muriate of potash and ammonium sulphate a slight decrease.

Sub-soil 8-16 in.

	L ₀	L ₂	M
January, 1956	4.78	5.19	5.00

Lime appears to have slightly increased the pH of the subsoil.

Scoring for Growth.—Wheat (var. 294M) was planted in May, 1955, and scored for growth in September, on the basis 0-10 = poor-good, The mean values are:—

P ₀	P ₁	P ₂	
4 $\frac{3}{4}$	7 $\frac{1}{2}$	8 $\frac{1}{2}$	
L ₀	L ₁	L ₂	M
6 $\frac{3}{4}$	7	7	6 $\frac{3}{4}$
N ₀ K ₀	N ₀ K ₁	N ₁ K ₁	
6 $\frac{3}{4}$	7	7	

The only marked responses were to superphosphate.

Yields.—Crop yields of wheat are given below in pounds per acre for 1954 and 1955 seasons.

Planted 294 M variety June, 1954. Harvested November, 1954

	P ₀	P ₁	P ₂	Mean	
L ₀	625	1273	1331	1076	
L ₁	882	1331	1357	1190	
L ₂	923	1249	1293	1155	
M	943	1354	1327	1208	
Mean	843	1302	1327		
					C.V. 12%
					Main Effects
					P
					L
					Body of table
L.S.D.:					
5 per cent.				82	95
1 per cent.				111	128
					221

L₁ and M lime treatments have given highly significant increases in yield. Superphosphate has given a highly significant increase in yield, but there is no significant difference between the two rates of application. The lime phosphate interaction is significant:—

N ₀ K ₀	N ₀ K ₁	N ₁ K ₁	
955	1261	1247	S.D. 1 per cent, 111

Potash has shown a highly significant increase, but the further addition of nitrogen has had no effect.

Planted 294 M variety May, 1955. Harvested November, 1955

	P ₀	P ₁	P ₂	Mean
L ₀	94	351	745	397
L ₁	179	559	751	496
L ₂	181	584	750	505
M	178	625	817	540
Mean	158	530	766	
C.V. 33 per cent P (Main Effects)				
L.S.D.:				
5 per cent.. .. .			95	
1 per cent.. .. .			128	

P₂ has shown a highly significant increase over P₁ and P₁ over P₀. The lime responses fall short of significance, but there are indications of effects similar to those of the 1954 season.

N ₀ K ₀	N ₀ K ₁	N ₁ K ₁	L.S.D.
408	485	561	$\left\{ \begin{array}{l} 5\% \ 95 \\ 1\% \ 128 \end{array} \right.$

The response to the combined NK application is highly significant.

(3) *Marindas*.—Lime applied February, 1954. Rates: L₀ = nil, L₁ = 8,300 lb., L₂ = 15,000 lb. dolomitic limestone. M = 7,400 lb. calcitic limestone per acre.

Effect on soil pH 0–8 in.

	L ₀	L ₁	L ₂	M
February, 1955	4.98	5.75	6.01	5.97
February, 1956	4.96	5.95	6.53	6.09

L₂ application at Marindas has raised the pH to the highest level of all four centres, a mean value of 6.53 with a range over 16 plots of 6.17–7.05.

The three fertilizers (N, P and K) appear to have had little if any influence on soil pH. There is no indication of any effect due to lime on the subsoil.

(4) *Kinangop*.—Lime applied March, 1954. Rates: L₀ = nil, L₁ = 3,400 lb., L₂ = 6,000 lb. dolomite limestone. M = 3,000 lb. calcitic limestone per acre.

Effect on soil pH 0–8 in.

	L ₀	L ₁	L ₂	M
March, 1955	5.03	5.50	5.88	5.81
November, 1955	5.02	5.67	6.06	5.90
	P ₀	P ₁	P ₂	P ₃
March, 1955	5.43	5.57	5.59	5.62
November, 1955	5.56	5.65	5.73	5.71
	N ₀ K ₀	N ₁ K ₁		
March, 1955	5.67	5.44		
November, 1955	5.84	5.48		

The lime applications are having the expected effect. Superphosphate appears to have increased the pH slightly and the NK application to have depressed it. Subsoil samples were not taken.

Yields

Barley planted May, 1955. Harvested November, 1955

					P ₀	P ₁	P ₂	P ₃	Mean
L ₀	..	..	..	..	1094	1750	1704	1801	1589
L ₁	..	..	..	..	1328	1831	1920	1652	1683
L ₂	..	..	..	..	1265	1873	1926	1763	1707
M	..	..	..	..	1402	1704	1705	1886	1674
Mean	..	..	..	..	1272	1790	1815	1776	

C.V. main plots 15 per cent sub plots 14 per cent.

P (Main Effects)

L.S.D.:

5 per cent..	..	..	203
1 per cent..	..	..	302

All phosphate applications showed a response but there were no significant differences between rates of application. There was no significant response to lime nor to the NK application.

Small subsidiary trials will be laid down in the Eldoret/Kaptagat area to investigate the possibility that the apparent lime response may be due to the relatively small amounts of phosphate in the lime applied.

Chemical Studies of the Soil as Influenced by Lime Fertilizer Applications

(1) *Phosphate*.—Soil samples (0–8 in.) taken November, 1955, from one replication of the Kinangop plots were fractionated by the method of Williams, and results are given below, as P. ppm. in soil:—

<i>Treatment</i>		P ₀	P ₁	P ₂	P ₃	averaged over lime and N, K treatments.
Acid soluble inorganic	..	17	24	29	48	
Alkali soluble inorganic	..	27	32	37	51	
Organic		103	101	115	125	

<i>Treatment</i>		L ₀	L ₁	L ₂	M	averaged over P and N, K treatments.
Acid soluble inorganic	..	30	26	30	32	
Alkali soluble inorganic	..	38	45	36	38	
Organic		108	121	115	100	

Both acid soluble and alkali soluble inorganic phosphate have shown a considerable increase after application of superphosphate. The increases in organic phosphate are erratic and relatively small. Lime appears to have had no effect.

(2) *Exchangeable Bases*.—Exchangeable calcium and magnesium were determined by the method of Mehlich in soil samples (0–8 in.) from the Kinangop and Marindas centres.

Kinangop. Sampled March, 1955. T.E.C.=11.6 me%

			L ₀	L ₁	L ₂	M
Ca me per cent	..	..	4.04	4.76	6.00	5.60
Mg me per cent	..	..	0.80	0.82	0.96	0.75
Ca/Mg	..	..	5.0	5.8	6.3	7.5

Marindas. Sampled February, 1955. T.E.C.=29.6 me%

			L ₀	L ₁	L ₂	M
Ca me per cent	..	..	4.68	9.93	11.69	12.26
Mg me per cent	..	..	1.54	2.00	1.91	1.30
Ca/Mg	..	..	3.0	5.0	6.1	9.4

At both centres, the application of dolomitic limestone has resulted in an increase in exchangeable magnesium, but calcitic limestone has caused a slight decrease. Both forms of limestone have widened the Ca:Mg ratio, but the effect is much greater at Marindas than at Kinangop.

(3) *Leaf Analysis*.—Leaf samples were collected in September, 1954, from the Marindas plots and the calcium magnesium and phosphorous determined. Results are given as percentages of each element on an air dry basis:—

Calcium and Magnesium

				L ₀	L ₁	L ₂	M
Treatment:							
Ca	..	..	..	0.511	0.592	0.571	0.592
Mg	..	..	..	0.129	0.164	0.156	0.150
Ca/Mg	..	..	..	4.0	3.6	3.7	3.9

Phosphorous

				L ₀	L ₁	L ₂	M	Mean
P ₀	..	..	..	0.147	0.154	0.149	0.152	0.151
P ₁	..	..	..	0.147	0.163	0.158	0.159	0.157
P ₂	..	..	..	0.144	0.173	0.169	0.162	0.162
P ₃	..	..	..	0.191	0.181	0.192	0.187	0.188
Mean	..	..	..	0.157	0.168	0.167	0.165	

The lime applications have increased both the calcium and magnesium contents of the leaf, but have had little effect on the Ca:Mg ratio. The phosphorous content has been increased by both lime and superphosphate dressing.

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Soil Organic Matter Studies

In continuation of the results obtained from fields of known cropping history given in the 1954 Report, soil samples (0-8 in.) were taken from two farms on the Kinangop in 1955:—

(a) *Uplands Orange Loam*.—Two neighbouring fields were sampled, one on which "good" crops of oats had been harvested and one on which the crops had been poor. Soil samples from fields of native grass adjacent to both cultivated fields were also taken. Organic carbon was determined by the method of P. Anne in which the soil and dichromate/sulphuric acid mixture are refluxed for five minutes and for which a recovery of about 97 per cent total organic carbon is claimed by the author.

	C	N	C/N
	<i>per cent</i>	<i>per cent</i>	
Good Oatfield—			
Native grass	4.5	0.39	11.5
Cultivated 6 years	4.2	0.33	12.7
Poor Oatfield—			
Native grass	5.4	0.38	14.2
Cultivated 6 years	4.6	0.28	16.4

(b) *Kinangop Grey Silt Loam*.—

	C	N	C/N
	<i>per cent</i>	<i>per cent</i>	
Native grass	3.4	0.26	13.1
Cultivated 3 years	2.4	0.19	12.6
Cultivated 3 years followed by sown grass 2 years	3.6	0.27	13.3

The main differences between the good and poor oat fields are the greater losses of C and N on the poor field following cultivation and also the higher C/N ratios both before and after cultivation.

On the grey silt loam the loss of organic carbon on cultivation has been much greater than on the orange loam but grass appears to have restored the organic matter status on the grey soil.

A number of the soils collected during the survey were examined by the technique of Hennebert and Livens for total humic colloids (M.H.T.) extracted by sodium fluoride and also that portion of the total precipitated by sulphuric acid (M.H.P.).

	VIRGIN SOIL			CULTIVATED SOIL		
	TOC*	MHT × 100 TOC	MHP × 100 MHT	TOC	MHT × 100 TOC	MHP × 100 MHT
	<i>per cent</i>			<i>per cent</i>		
Uplands loam "good oats"	4.5	10.2	12	4.2	10.8	18
Uplands loam "poor oats"	5.4	8.5	17	4.6	8.7	19
Kinangop grey silt loam . .	3.5	5.6	49	2.4	6.1	37
Menengai	4.1	5.7	27	3.3	7.0	37
Kitale	3.4	6.3	23	2.0	8.7	15

TOC*=Total Organic Carbon.

The percentage of total humic colloids was considerably higher in the Uplands loam "good oats" field than in any of the other fields. Cultivation at all centres has resulted in a loss of total organic matter, but the percentage of total humic colloids in the organic matter has shown an increase.

The acid precipitable fraction varied greatly from district to district, but the effect of cultivation was less marked and somewhat erratic.

Soil Surveys

The year 1955 is notable for the initiation of development of Kenya's first major irrigation project (Mwea-Tebere Scheme); for the comprehensive surveys by Sir Alexander Gibb & Partners of the irrigation resources of the Lake Victoria drainage area in Kenya, and for the detailed investigation of a possibility for major irrigation at the head of the Tana Delta.

MWEA-TEBERE

Early in the year the soils of 76,000 acres of the Mwea-Tebere area were surveyed by a team of field officers operating under the direction of an officer of the Chemistry Section. The only mapping framework then available comprised the photographs which had been taken in 1954, during the aerial survey of the area. Accordingly, in collaboration with Primary Surveyors of the Hydraulic Branch of the Public Works Department a technique was evolved for plotting soils data and boundaries on the photographs themselves, pending the arrival of the maps, and ultimately for transposing the information from the photographs to the maps when they were ready. Soils mapping was based on field observation supported by the inspection of profiles distributed at approximately quarter-mile intervals. It transpired that the flight paths flown in the aerial survey were in the vicinity of three-quarters of a mile and the photograph centre along each flight path half a mile apart. As photograph centres were to appear on the ultimate aerial survey maps, these points were taken for building up the framework of profiles for inspection: pits were dug on the ground at photograph centres, at the half-way point between photograph centres and at the same spacing along traverses a quarter of a mile on each side of each flight path. The distribution of the pit sites was worked out at base on the photographs before the area was visited. The sites of the pits in the field were determined by identification on the ground of local detail shown on the photographs and the fixation of the pits in relation to such detail. At the time of siting the pits, photographic and ground indications of the soils pattern in the vicinity of the pits were compared and were used for the delineation on the photographs of the soils and soil boundaries observed in the field. As the survey progressed so was more detailed examination and profile inspection undertaken in those areas which needed it. Attention was concentrated on the differentiation and mapping of the swamp and heavy black rice soils, of the red loam and sandy loam upland crop soils, and of the intermediate very dark brown rice or upland crop soils; and on effective depth of soil.

Apart from some sandy loam soils of Basement Complex origin along the southwest border of the scheme and very limited areas of associated sandy clays in nearby lower-lying land, and from a tendency for black soils in the extreme south to occur on undulating land, the soils pattern reported in 1954 for the Mwea-Tebere area was found to persist throughout the region surveyed.

In the survey some 14,000 profiles were examined and of these 115 selected on the basis of observed geographical and soils distribution, were sampled for laboratory examination.

At the end of the year, the maps on which the survey was to be transposed were still awaited.

TANA DELTA

A soil survey of the Tana Delta Scheme was also undertaken by a team of field officers operating under the direction of the Chemistry Section. Here, the Primary Survey was undertaken by ground staff on a grid traverse basis and profile pit sites at 1,000-ft. intervals along parallel traverses at 2,000-ft. spacings were actually pegged on the ground by the Primary Surveyors. Useful interpretation assistance has been provided by an uncontrolled aerial mosaic which has been assembled in connexion with the undertaking of the Primary Survey.

In the Tana Delta Scheme area as in the Flood Plain, old river channels are marked by bands of sandy soils, though where these occur they are frequently so sandy as to be of low potential fertility. However, the most widespread soils in the area are heavy and minor variation in the drainage and the topography of these soils and of the fire hazards to which they are subject appear to be accompanied by very marked variations in salinity, alkalinity, mottling intensity and pallidity. These variations are so marked as to be of major agricultural importance. Unfortunately, no striking correlation between salinity and alkalinity status and profile characteristics or vegetation distribution has been observed in the area and so a detailed analytical survey of the scheme has become necessary. In consequence, all profile sites have been sampled for laboratory examination.

LAKE VICTORIA BASIN

The Chemistry Section was made responsible for the analysis of the many soil and water samples collected by the Sir Alexander Gibb survey teams in the Lake Victoria Basin investigation. As these samples were accorded topmost priority for laboratory examination little progress has been possible in the examination of the samples collected in the course of the Mwea-Tebere and the Tana Delta surveys.

PROVINCIAL SOIL MAPS

During the year Provincial officers in Nyanza and Rift Valley attempted the production of soil maps of their Provinces. These maps have provided some basis for getting the surveys on to a more sound footing and proposals covering the verification of the recorded information, the improvement of the basis of classification and the advancement of soil surveys in these provinces have been put forward. A consolidated demonstration soil map on a scale of 1/500,000 of the Central Kenya Highlands was prepared for exhibition at the 1955 Royal Show, Nairobi. Information recorded on this map is incorporated by the Soil Survey Division, E.A.A.F.R.O., in the new 1/2,000,000 soil map of East Africa which is now in course of preparation.

EXPERIMENT STATIONS

The Soil Survey Division, E.A.A.F.R.O., undertook a soil survey of the Agricultural Experiment Station, Ol Joro Orok, and have mapped soils distribution there. Soil surveys of Embu Experiment Station and of the Irrigation Experiment Station, Tebere, also have been undertaken.

Nitrogen Studies

Determination of the ammonia nitrogen content of rain-water collected at Scott Agricultural Laboratories was continued. The results from daily collections were:—

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall	0.44	4.62	1.37	7.98	5.71	0.09	0.57	0.63	1.07	1.92	1.70	4.89
N added by rain: lb./acre	.068	.499	.152	.858	.296	.001	.022	.035	.143	.305	.128	.613
Lb./acre per inch of rain	.154	.108	.111	.108	.063	.011	.038	.056	.134	.159	.076	.126

Total Addition of Ammoniacal N

Lb./acre, 3,120.

Lb./acre/inch of rainfall, 0.101.

Lb./acre/inch of rainfall (mean for six years), 0.080.

The average ammoniacal nitrogen content of rainfall at Scott Agricultural Laboratories in 1955, was higher than in any previously recorded year. Even so, the ammoniacal nitrogen contribution by rainfall remains low.

Njoro Pumice Soils**EXPERIMENTAL**

Two pot experiments were performed using wheat and perennial ryegrass as indicator crops. The experiments were designed to investigate the effect of omitting one nutrient element in turn from an addition of nitrogen, phosphorus, potassium, magnesium, iron, manganese, copper, zinc, boron and molybdenum. The rates of application of the nutrient salts are shown in the following table:—

Salt							Equivalent rate/acre (lb.)
Ammonium sulphate	..	..	..	..	..	..	200
Disodium hydrogen phosphate	..	..	..	..	..	..	140
Potassium sulphate	..	..	..	..	..	..	200
Magnesium sulphate	..	..	..	..	..	..	200
Ferrous sulphate	..	..	..	..	..	..	100
Manganese sulphate	..	..	..	..	..	..	100
Copper sulphate	..	..	..	..	..	..	40
Zinc sulphate	..	..	..	..	..	..	40
Sodium borate	..	..	..	..	..	..	10
Sodium molybdate	..	..	..	..	..	..	0.5

Pots containing 500 g. air-dried soil were sown with either 10 wheat grains or 18 ryegrass seeds. After germination, the plants were thinned so that each pot contained six wheat plants or 12 ryegrass plants. Glass-distilled water was used to maintain the soil in each pot at 2/3 of field capacity. Each experiment was provided with four replications.

RESULTS*(a) Wheat Experiment*

The following table shows the times of ear emergence, weight and number of harvested grain per pot, 1,000 grain weight, and yield of straw.

The omission of any given nutrient element appears not to influence the time of ear emergence. Grain yield is significantly reduced by the omission of nitrogen and copper. In the case of nitrogen, loss of yield appears to be due to a reduction in grain number, while in the case of copper this appears to be due to the formation of smaller grains. Straw yield is significantly reduced by the omission of nitrogen and copper.

Treatment	Time of Ear Emergence (days from sowing)	Relative Grain Yield (Plus All = 100)	Relative Grain Number (Plus All = 100)	Relative 1000 Grain Weight (Plus All = 100)	Relative Straw Yield (Plus All = 100)
Omit N ..	67.4	76.8***	72.5***	106.9	72.6***
Omit P ..	71.0	101.8	100.0	101.4	96.1
Omit K ..	70.5	103.5	98.9	104.2	101.1
Omit Mg ..	70.2	105.1	105.5	99.8	104.2
Omit Fe ..	70.9	100.0	92.3	107.9	98.8
Omit Mn ..	69.2	105.3	101.1	103.8	103.3
Omit Cu ..	72.0	85.1**	93.4	90.8*	85.6**
Omit Zn ..	69.2	98.3	93.4	105.0	94.9
Omit B ..	70.2	105.6	97.8	107.9	103.5
Omit Mg ..	70.0	95.9	95.6	100.3	103.7
Plus All ..	69.9	100.0	100.0	100.0	100.0
Omit All ..	70.7	74.5***	73.6***	101.3	69.1***
LSD* ..	4.1	10.2	12.9	8.5	8.6
LSD** ..	5.5	13.6	17.3	11.5	11.5
LSD*** ..	7.2	18.0	22.8	15.1	15.2
Coefficient of variation..	4.04%	7.34%	9.53%	5.78%	6.32%

Treatment Means differing significantly from the "Plus All" treatment are shown in the usual way.

(b) *Ryegrass Experiment*

The following table shows the relative yields of Dry Matter at each of two cuts.

Treatment							RELATIVE YIELD (Plus All=100)	
							1st cut	2nd cut
Omit N ..	..	..	..	..	..	..	57.8***	85.6†
Omit P ..	..	..	..	..	..	..	88.6	88.7
Omit K ..	..	..	..	..	..	..	83.1*	91.2
Omit Mg ..	..	..	..	..	..	..	69.2***	88.6
Omit Fe ..	..	..	..	..	..	..	95.4	88.6
Omit Mn ..	..	..	..	..	..	..	88.2	98.7
Omit Cu ..	..	..	..	..	..	..	84.6*	87.0
Omit Zn ..	..	..	..	..	..	..	86.5	97.5
Omit B ..	..	..	..	..	..	..	99.8	97.4
Omit Mo ..	..	..	..	..	..	..	97.4	89.6
Plus All ..	..	..	..	..	..	..	100.0	100.0
Omit All ..	..	..	..	..	..	..	51.8***	85.0*
†LSD* ..	..	..	..	..	..	..	14.6†	14.6
†LSD** ..	..	..	..	..	..	..	19.6†	19.7
†LSD*** ..	..	..	..	..	..	..	26.0†	26.0
Coefficient of variation ..	..	..	..	..	..	..	12.14%	11.10%

†Limiting values of the least significance differences since an analysis of covariance was carried out to correct for differing plant numbers arising through wind damage.

‡Almost significant at the 5 per cent level.

The ryegrass made very poor growth after the first cut and tended to be uniform with regard to treatments.

The first cut showed the omission of nitrogen, potassium, magnesium and copper to result in a fall in dry matter production, while the second cut only showed the omission of nitrogen to affect dry matter production.

DISCUSSION

The two nutritional factors influencing the yield of wheat appear to be nitrogen and copper, and the two important nutritional factors influencing the yield of ryegrass appear to be nitrogen and magnesium although copper and potassium also appear to have a small effect. Appropriate soil data are shown in the following table:—

		Method of Analysis
pH	6.10	Soil:Water Ratio=1:1
Carbon (corrected)	2.74%	Walkley & Black (1934)
Nitrogen	0.230%	Methods of Analysis of the A.O.A.C., 6th Ed., 1945.
C:N Ratio	11.9	
Base Exchange Capacity	21.4 me%	Peech (1951)
Exchangeable Potassium	4.15 me%	Peech (1941)
Exchangeable Calcium	10.7 me%	Peech (1941)
Exchangeable Magnesium	2.01 me%	Peech (1941)
Exchangeable Manganese	16 ppm	Peech (1941)
Hydroquinone Reducible Man- ganese	128 ppm	Sherman <i>et al</i> (1942)
Available Copper	0.03 ppm	Steenjberg & Boken (1950)
Available Phosphate	42 ppm	Truog (1930)

The potassium response of ryegrass is unexpected in view of the high level of exchangeable potassium in the soil; the response is probably ascribable to the fact that significance at the level $P = 0.05$ is associated with a false result one time in 20. The magnesium response is probably due to the unfavourable potassium: magnesium ratio rather than to a deficiency of magnesium as such. The available copper status of the soil is very unsatisfactory when compared with Steenjberg & Boken's (1950) recalculated limits.

Crop Symptoms	ppm Available Copper
Severe deficiency	0.08
Deficiency	0.157
Sound Crop	0.752

Previous laboratory fixation studies have shown applications of 40 lb. and 200 lb. of copper sulphate per acre to raise the available copper status to 0.37 ppm, and 3.1 ppm, respectively. In the absence of fixation, the available ppm. status would be raised to 5.1 ppm. and 25.4 ppm respectively.

Although yields of wheat and ryegrass in the pot experiments were influenced by the treatments, all plants, irrespective of treatment, showed die-back from the leaf tips, leaf blade mottling, and in the case of wheat a large number of empty ears. Further work is being undertaken to investigate the possibility of heavy metal toxicity being responsible for the poor crop performance on this soil.

In the field, wheat has been found to respond to small dressings of copper sulphate, but not to sulphate of ammonia, while grass (*Cynodon dactylon*) has been found to respond to sulphate of ammonia. It is possible that increased production of wheat and grass would result from moderate dressings of sulphate of ammonia plus copper sulphate, and in the case of grass the inclusion of magnesium sulphate may be advantageous.

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Bracken Soils

A pot experiment was performed to test the effect of lime phosphate, manure, magnesium and molybdenum on the growth of dwarf beans. Lime was applied as calcium hydroxide to produce theoretical pH values in the soil of 4.2, 5.0, 5.8 and 6.6; the corresponding rates per acre being 0, 1,720, 4,480 and 9,700 lb. Phosphate was applied as calcium phosphate at a rate equivalent to 100 lb. double supers per acre. Manure, magnesium sulphate and sodium molybdate were applied at rates equivalent to 10 tons, 200 lb. and 1 lb. per acre respectively.

The experiment was arranged as a half replicate of a 2^6 , the defining contrast being the 5th order interaction.

RESULTS

The accompanying table shows the main effects of lime, phosphate, manure, magnesium and molybdenum on the number of beans formed and weight of beans harvested.

No interactions were significant and only the main effect of lime was found to be significant. The three upper levels of lime resulted in a very highly significant increase in the number of beans formed and in the weight of beans harvested. There were no significant differences between the upper three levels of lime.

The behaviour of lime is best explained by the equation:—

$$y = -33.60 - 12.29 (\text{pH}) - 0.98 (\text{pH})^2$$

where (pH) = the pH level in the soil produced by a given dressing of lime, and y = the yield of beans.

The maximum yield, as obtained by differentiating the equation and equating to zero, is obtained when the soil is limed to pH 6.25; the corresponding dressing of slaked lime being 7,140 lb. per acre.

Treatment							Number of Beans per pot	Weight of Beans per pot (gm.)
Lime—								
L ₀	..	..	..	..	..	..	2.75	0.76
L ₁	..	..	..	..	..	..	10.38	3.55
L ₂	..	..	..	..	..	..	12.89	4.73
L ₃	..	..	..	..	..	..	13.12	5.02
LSD*							3.61	1.71
LSD**							4.98	2.68
LSD***							6.67	4.56
Phosphate—								
P ₀	..	..	..	..	..	..	10.81	3.94
P ₁	..	..	..	..	..	..	8.75	3.09
Manure—								
Man ₀	..	..	..	..	..	..	10.13	3.50
Man ₁	..	..	..	..	..	..	9.44	3.53
Magnesium—								
Mg ₀	..	..	..	..	..	..	9.63	3.60
Mg ₁	..	..	..	..	..	..	9.94	3.43
Molybdenum—								
Mo ₀	..	..	..	..	..	..	9.75	3.31
Mo ₁	..	..	..	..	..	..	9.81	3.72
LSD*							2.60	1.21
LSD**							3.53	1.89
LSD***							4.74	3.22
Coefficient of variation ..							36.39%	37.78%

Pyrethrum

Further study has been made of the false pyrethrins—those extraneous substances which assay as, but are unrelated to the pyrethrins—and more particularly of those which are present in the pyrethrin II hydrolysates. Examination by paper chromatography, of the acid fraction normally titrated as pyrethrin II in the standard analytical procedures has revealed that at least four acids, in addition to the authentic chrysanthemumdicarboxylic acid derived from pyrethrin II and cinerin II, can occur in this fraction.

The method adopted has been to apply the ether soluble material remaining in pyrethrin hydrolysates after removal of chrysanthemic acid and the barium insoluble acids to chromatographic filter paper sheets and to develop these by downward flow with a solvent system of ethanolic ammonia. The component acids, in the form of their anions, travel down the paper at varying rates relative to the developing solvent, these rates being characteristic for each substance. When the solvent front has covered a convenient distance the papers are removed from the chromatography cabinet, dried at an elevated temperature and then sprayed with a suitable acid-base indicator such as bromocresol purple. The acids are in this way shown up as yellow spots against a blue background.

Having then obtain a qualitative picture of the composition of the pyrethrin II acid fraction it was desirable to ascertain the relative amounts of the various acids present. The above method was therefore adapted for quantitative use on a semi-micro scale. A quantity of the material of the order of 100 mgms. was

applied to sheets of thick-grade paper as a thin horizontal streak, the papers were then developed with solvent as previously described, the acids migrating down the paper as a series of bands. After drying, the chrysanthemumdicarboxylic acid band was demarcated by light spraying with chlorophenol red indicator and after further drying was excised. The areas of paper above and below this zone as far as the solvent front were also cut out and the three zonal portions thus obtained eluted individually by chromatographic washing with dilute aqueous ammonia. The eluates after concentration and acidification were extracted with ether and the residues from evaporation of the ethereal extracts weighed and titrated with alkali. The proportion both by weight and by titration of false pyrethrins in the pyrethrin II fraction could thus be estimated.

A series of such determinations was carried out on a number of flower samples varying in pyrethrin II content relative to pyrethrin I and in total pyrethrins present. It was found that false pyrethrins accounted for from 9 per cent to over 17 per cent by titration of the respective pyrethrin II fractions while their proportion by weight in most cases exceeded 30 per cent. Furthermore, the amount of false pyrethrins showed no correlation either with the ratio of pyrethrin I to pyrethrin II or with the total pyrethrins. It might have been expected that a relatively high pyrethrin II figure would indicate a correspondingly high false pyrethrin content whereas in actual fact the sample which gave the highest result for false pyrethrins was that with the lowest relative pyrethrin II content.

Thus it seems evident that there are no external indications which might serve as a criterion in assessing, even approximately, the false pyrethrin content to compensate for the lack of specificity of present analytical methods for pyrethrin II.

Analytical Data

The following data obtained during 1955, are of general interest:—

Foodstuff	Moisture	Oil	Crude Protein	Fibre	Ash	
Barley (grain) ..	13.20	1.82	14.23	4.84	6.71	—
Brewers grains ..	81.79	1.15	4.10	2.64	0.88	
Canna* ..	11.82	0.12	3.69	3.04	3.73	
Canna** ..	11.75	0.17	5.85	3.39	6.06	
Cashew nuts ..	5.23	—	20.05	—	—	
	5.45		20.55			
Copra cake ..	7.17—	13.03—	23.90			
	9.27	26.37				
Copra cake ..	12.42	22.04	16.94	10.20	10.81	
Cottonseed cake ..	6.18—	4.04—	27.14—			sand 3
	11.84	15.77	45.97			0.122—
						0.147
Cottonseed cake ..	8.54—	8.19—	37.07—	13.28—	6.15—	
	8.57	9.12	38.24	14.70	6.18	
Groundnut cake ..	6.37—	5.34—	32.62—			
	10.92	17.47	53.85			
Groundnut cake ..	10.24	9.74	46.42	3.97	7.97	
Kikuyu grass silage†	68.75	2.45	10.66	32.54	9.89	pH 4.96
Lucerne leaf meal..	8.20		19.75			Carotene
			(17.48			64 ppm.
			D.C.P.)			

Foodstuff	Moisture	Oil	Crude Protein	Fibre	Ash	
Lupin (seed) ..	10.24		30.46			
Lupin (seed) ..						alkaloid 0.297- 0.743
Maize (cobs) ..	9.30	0.55	3.28	30.90	4.35	
Maize meal ..	11.46- 12.01	3.96- 4.23	9.13- 9.26	1.92	1.67- 1.69	
Maize silage† ..	83.96		9.35			
Maize silage† ..		1.97		35.41	12.09	
Maize silage† ..	68.67- 87.93		8.65- 18.9			pH 5.8- 6.7
Maize and Oat silage† ..	83.75		10.27			pH 6.23
Oats (grain) ..	12.23	5.09	11.89	12.56	4.18	
Oats whole plant ..	82.74	0.41	1.88 (0.41 D.C.P.)	5.51	1.63	
Oat silage† ..	67.24- 83.50		6.26- 10.3			pH 5.2- 6.8
Pyrethrum waste ..	12.71	0.64	13.09	21.81	7.71	
Rape silage† ..	74.53		15.8			pH 5.8
Rhodes grass silage†	74.12		4.92			pH 5.4
Rice dust ..	11.38	9.12	11.04	5.84	6.67	
Rice meal ..	12.68	1.54	5.61	8.22	6.56	
Russian Comfrey meal ..	2.34- 13.45	1.16- 3.17	13.91- 26.75	7.36- 12.84	3.47- 34.28	
Ryegrass Perennial	10.00		13.60- 22.64			one sample (P ₂ O ₅ 0.525) (CaO 0.433)
Sudan grass and Dolichos silage†	68.75					
		2.32	6.84			
Sudan grass and Oats silage† ..	78.64- 81.55	2.83- 3.10	6.50- 6.66			
Sunflower cake ..	6.97- 8.92	9.81- 16.31	23.79- 28.95	21.93- 29.22	3.01- 3.64	
Sunflower meal ..	12.30		6.90			

*Dried after expression of juice.

**Dried after chopping.

†pH and Moisture Determinations expressed on fresh basis. Remaining determinations expressed on dry matter basis.

D.C.P.= Digestible Crude Protein determined by enzymic digestion (pepsin).

Agricultural Products

Chillies.—Normal pods: 9.5 per cent moisture, 14.7 per cent ether extract, 2.1 per cent volatile ether extract; Large pods: 42.7 per cent moisture, 9.8 per cent ether extract, 2 per cent volatile ether extract.

Cottonseed oil.—Free fatty acid as oleic acid 0.01–0.4 per cent colour on Lovibond Scale, 1 centimetre cell 0.0–1.1R, 1.6–5.4Y.

Papain: 7.8–8.3 per cent moisture, 8.1–10.5 per cent ash. proteolytic activity: ml. N/10 caustic soda, 51.7–60.0.

Fertilizers and Manures

Material	Moisture %	N %	P ₂ O ₅ %	K ₂ O %	CaO %	Mgo %	
Bat Guano	11.3	1.73	8.77	—	—	—	—
Blood and sawdust ..	10.9	2.54	0.16	0.14	—	—	—
Boma manure	7.5	0.97	0.59	0.45	—	—	—
Chicken manure ..	3.9	1.12	0.23	1.00	—	—	—
	13.7	2.34	3.28	1.06	—	—	—
Deep litter	8.7	1.65	2.02	1.42	—	—	—
Double supers	8.4	water soluble	40.7	—	—	—	—
Farmyard manure ..	73.7	0.42	0.16	1.08	—	—	—
	76.0	0.59	0.28	1.26	—	—	—
Gypsum	—	—	—	0.1	29.0	0.2	SO ₄ 44.5 R ₂ O ₃ 11.0 CO ₃ 1.5 OH 12.2 R ₂ O ₃ 11.8 6.8 17.8
Lime	—	—	—	—	58.7	0.9	acid insoluble loss on ignition
Manure air dried ..	5.9	1.44	0.08	0.33	22.2	—	—
	9.8	2.52	0.61	3.94	—	—	—
Manure decomposed aerobic conditions ..	73.6	1.89	—	—	—	—	—
Manure decomposed anaerobic conditions ..	75.7	1.61	—	—	—	—	—
Municipal wastes, Mombasa	1.2	0.10	0.13	0.61	7.2	—	—
	2.6	0.61	0.21	1.15	12.6	—	—
Sewage farm solids ..	10.2	3.29	1.84	0.18	—	—	—
Sisal waste	5.9	1.37	0.52	0.31	6.3	—	—
Seychelles guano ..	5.6	0.23	28.4	—	—	—	—
	9.9	0.26	29.2	—	—	—	—
Soda phosphate	0.15	—	19.13	—	—	—	—
	3.23	—	27.04	—	—	—	—
	—	Citric soluble	3.70	—	—	—	—
Super raw phosphate ..	3.5	—	20.60	—	—	—	—
	—	Citric soluble	27.0	—	—	—	—
	—	—	14.1	—	—	—	—
Wattle bark ash	—	—	1.55	0.27	—	—	—

Acknowledgments and Tribute

Acknowledgment is due to the co-operation of Field Service and of Field Experiment Staff for its part in the soil surveys and in the field experiments in which the Chemistry Section collaborates and which are discussed in this report. Acknowledgment is due also to the forbearance of those members of the public to whom, on account of our many commitments, we have not been able to extend the service which they expect of us. Officers of the Chemistry Section have continued to work with typical vigour.

On 30th June, on the occasion of the reorganization of the Pyrethrum Services, Mr. V. A. Beckley finally retired from Government service. His retirement marked the end of a 33-year-long association with the Agricultural Department which is notable for his contributions to the development of agriculture in Kenya. He left his mark in the form of soil conservation consciousness in the industry generally, in the methods used for processing sisal and isolating its by-products and in the founding of the pyrethrum and the essential oil industry. At the time of writing we mourn his passing for Mr. Beckley died at Mombasa on 10th June, 1956.

At the end of the year news was received of the impending transfer of Dr. C. C. Webster to Malaya, as Deputy Director of Agriculture. We were all greatly stimulated by our association with Dr. Webster as the chief research officer of the Department.

Dr. L. A. Whelan contributed the sections of this report on soil organic matter studies and on lime—fertilizer experiments, Mr. B. Butters the sections on Njoro pumice soil and bracken soil and Mr. H. Hodgson the section on pyrethrum.

E. BELLIS,
Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER

I.—Wheat General

The season was characterised by a severe drought of some eight weeks after planting, followed by excessive rainfall during the ripening period. This rain continued late and all crops suffered from a wet harvest. As a consequence, the wheat crop was poor and yields were below those of last season.

The monthly rainfall totals at Njoro, and the number of rainy days were as follows. This distribution reflects the general picture in the country.

RAINFALL

Month			1955	26 Years' Average
January	..	..	1.95 (13)	0.85
February	..	..	4.86 (10)	1.27
March	..	..	0.46 (4)	2.60
April	..	..	4.55 (13)	5.63
May	..	..	3.76 (17)	4.24
June	..	..	1.82 (10)	3.35
July	..	..	2.53 (14)	4.44
August	..	..	6.64 (22)	4.95
September	..	..	6.44 (18)	2.70
October	..	..	2.52 (13)	1.96
November	..	..	2.89 (13)	2.51
December	..	..	2.77 (10)	1.81
Total	..	..	41.19 (157)	36.31

The wheat crop this season amounted to 1,354,364 sacks of 200 lb., compared with 1,485,500 sacks in 1954. This represents a decrease of some 131,000 sacks (9 per cent) on last season. Acreage figures are 344,861 for the present season compared with 290,963 in 1954, an increase of some 54,000 acres (18 per cent). Corresponding yields are 3.93 and 5.10 sacks per acre respectively. The comparison may be summarized as follows:—

1954			1955		
Acres '000	Sacks '000	Sacks/acre	Acres '000	Sacks '000	Sacks/acre
291	1,485	5.10	345	1,354	3.93

REVIEW OF MAIN VARIETIES

The main varieties grown during the year and their acreage percentages for the three-year period 1953–1955 are appended.

Acreage Percentages 1953-1955

Variety	1953	1954	1955
Sabanero	16.4	13.3	17.9
131	11.2	10.0	12.8
341	1.5	7.6	11.2
1066	13.1	9.8	9.4
294/KS	17.9	12.7	7.7
184	1.5	5.0	6.5
D.C. Ceres	2.1	6.2	5.2
337	2.8	6.7	4.8
360.H	9.8	7.0	4.4
EQ/KTI	7.4	3.7	3.9
261.E	—	—	1.5
Regent	—	0.5	1.4
354	—	—	0.9
261.R	1.0	1.2	0.6
356	—	—	0.5
Reward	—	0.2	0.4
Pohl's Plateau	—	0.3	0.1
318/KP	7.8	6.8	—
Baby Equator	—	2.9	—
Others	7.5	6.1	10.8
TOTAL	160.0	100.0	100.0

The main differences in the pattern of distribution are the fall in popularity of 294, 360, 337 and 318 and the rise in Sabanero, Regent, 261.E and 341. Variety 318 dropped from 6.8 per cent to become a minor variety this season. It was forecast last season that the three wheats 294, 360 and 318 would drop in acreage due to increasing rust susceptibility. The five premium varieties in the aggregate were unchanged in acreage. Nevertheless two of them, 184 and 261.R, accounting for half the total were badly damaged by stem rust and it is expected that they will virtually disappear from cultivation in the future.

RUST AND OTHER DISEASES

Climatic conditions caused a severe and widespread outbreak of stem rust (*Puccinia graminis tritici*), the worst for many years. Stem rust also severely damaged the wheat crop in the Northern Province of Tanganyika and was the worst outbreak experienced in that region for a considerable time. Unlike other years, rust came early enough to cause widespread damage and reduction in yield, no doubt due to the setback resulting from the drought. No areas escaped, and the disease was present from the lowest to the highest farms.

Most varieties were affected to varying degrees. Those badly damaged include 261, 294, 318, 360, 341 and 184, the latter two being completely destroyed on some farms. It is obvious that these varieties can no longer be considered reliable and it is expected that the acreage sown to them will decline markedly in 1956; some may go out of cultivation altogether. Even those varieties usually considered moderately rust resistant have not escaped, and attacks were quite severe on 131, 1066 and Sabanero. Three wheats stood out as showing resistance to attack; they were Canadian Regent and the country-bred varieties 354 and 321. The annual rust survey showed that the prevalent races in East Africa during the year were K14, and the new races K15 and K16.

see next p.

In addition to stem rust, other diseases showed marked increases. Glume blotch (*Septoria nodorum*) was widespread and attacked particularly the varieties 318 and Regent. Both Take All (*Ophiobolus graminis*) and *Pyrenophora* root rot caused much damage in the higher area. Leaf and ear rusts (*P. triticea*) and (*P. glumarum*), in contrast to stem rust, were less in evidence.

BLACK STEM RUST—APPEARANCE OF TWO NEW RACES

A new physiologic race of black stem rust has arisen and yet a further is suspected. These two new races make the 15th and 16th stem rust races to be isolated in East Africa and are accordingly designated K15 and K16. The K15 was found on a new variety in the multiplication plots at Njoro and K16 is suspected on a number of established varieties in Kenya.

The reactions of the two new races on the Kenya differentials, which serve to distinguish them from the earlier races, are given below. Race K16 shows reactions very similar to K14 but with rather lower virulence on the differential 117.A and higher on 184.P.

Table 1

Differential Variety	K15	K16	K14
K.G.	1-2	3	3
Einkorn	1	not tested	1-2
Reliance	3-4	3	3
B.256.G	3	3-4	4
58.F	3-4	4	4
117.A	2	2-3	3-4
184.P.2.A.1.F	2	2-3	1
367.BR.1.D.4.F	;	1	1

II.—Wheat Breeding

The main work is centred at Njoro and Molo, whilst further testing and multiplication are carried out at Eldoret, Rongai, Ol Joro Orok, Kinangop, and at Egerton College.

In view of the expanded programme and large amount of material now being carried, such detail as was given in past reports will no longer be possible. Only special points of interest can now be covered in the annual report and it is the intention to issue special bulletins from time to time covering points of more detail.

CAGE MATERIAL AND NEW ACCESSIONS

(a) Njoro

At Njoro 23 new crosses were made involving varieties, extracted from earlier nurseries and the Rockefeller Collection, which showed resistance to the latest races of stem rust. Forty-four new accessions were grown and 114 from earlier sources. The total number of crosses under selection was 82, mostly F_3 's and F_4 's carried on from the previous year. The work was severely hampered by very late rains and excessive disease.

(b) Molo

At Molo, 173 cultures of the more promising selections from the crosses 384 and 385 were grown for pure seed stocks. The majority of the work was devoted to the development of 23 new crosses designed to provide better quality varieties for the higher areas.

CO-OPERATIVE RUST NURSERIES

This is the second year of our participation in these nurseries. The International Nursery received from America contained 365 entries and the Near East Co-operative Wheat Rust Nursery from F.A.O., Rome, 363 entries. A full report on the performance of the varieties under test was sent to the appropriate authority and a total of 155 varieties from these nurseries were harvested for further use.

WHEATS UNDER INITIAL MULTIPLICATION

Space will not allow for a full report on all varieties and only those of especial merit will be mentioned.

(a) Njoro

In addition to some 113 bulk populations of various crosses, multiplication was begun with 99 varieties from earlier rust nurseries and 27 selections from the five crosses (372, 374, 377, 381 and 398) mentioned in previous reports. In the larger multiplication plots there were 29 varieties from various sources. Opportunity was taken to purify bulk stock of the differentials and provide fresh nucleus stocks of two established varieties. Greater use is now being made of bulk selection in field plots, which method is gradually supplanting the pedigree system in the early stages. This allows a greater amount of material to be handled and so avoids the weakness of past work which was felt to be too narrow in scope.

(b) Molo

The entire programme was devoted to the bulking of 75 selections from the 384 and 385 crosses, the larger of which have now reached about 1/30th acre in size. Some of these looked extremely attractive and proved to have shorter straws and greater rust resistance than the Equator parent. Those selected will be sent for baking tests for quality determination.

Fresh stocks of 362.A.1.D.1 and B.1.E.4 were multiplied to give a pure seed supply. These were the first two selections from this cross to be given out to farmers.

(c) Other Stations

The ten small multiplication plots at Rongai were killed by the June drought. At Eldoret only three wheats were multiplied; 359.AA.8.B.1.A will be continued and both 356.A.4.D and 466.4.M.M.1.M discarded on account of stem rust and glume blotch susceptibility.

At Ol Joro Orok, 362.B.1.A.1 and B.1.A.2 were multiplied. The former will be discarded in favour of the latter which has shown better performance in trials.

VARIETY TRIALS

Yield trials were carried out as usual at Njoro, Eldoret, Ol Joro Orok and Kinangop. The following table shows the quantity of all three cereals under trial.

Table II

Station	VARIETIES IN TRIALS			OBSERVATION PLOTS		
	Wheat	Barley	Oats	Wheat	Barley	Oats
Njoro	25	16	—	279	10	—
Eldoret	21	16	21	1	—	11
Ol Joro Orok	15	15	14	—	7	20
Kinangop	15	15	14	—	7	20
Kitale	—	12	10	—	11	7
Rongai	13	—	—	10	2	—
Molo	—	16	13	85	—	1
Totals	89	90	72	375	37	59

(a) Wheat Variety Trials—Njoro, Eldoret and Kinangop

Due to drought, hail and bird damage these trials were virtual failures. No details will be given, but it is of interest to record that early varieties suffered particularly severely; at Eldoret there was a complete reversal of the order of yield as compared with 1954.

*(b) Wheat Variety Trial—Ol Joro Orok**Table III*

Variety	Yield (bags 200 lb./acre)	POSITION	
		1955	1954
Capella	6.61	1	11
362.P.1.B.3	6.32	2	5
B.1.A.2	5.38	3	1
B.1.A.1	4.89	4	2
B.1.E.4	4.61	5	4
B.1.D.3.D	4.47	6	14
350.AD.9.C.2	4.17	7	12
362.B.1.I.1	4.15	8	7
B.1.A.3	3.82	9	3
A.1.J.1	3.57	10	10
R.64	3.53	11	13
362.J.1.B.3.D	3.34	12	8
A.1.D.1	3.22	13	9
B.1.A.4	2.87	14	6
350.AJ.3.C.1	2.61	15	15
Mean	4.24		
Significant Differences:			
P.05	1.72		
P.01	2.26		

At Ol Joro Orok the Italian durum Capella again tops the list, followed closely by the 362.B selections. There is a general tendency for the high ranking varieties in 1954 to retain their position this season and vice versa though exceptions do occur.

WHEATS UNDER FIELD MULTIPLICATION

The quantity of material under field scale multiplication on farms again increased. The following table, which includes also barley and oats, shows the amounts involved. This multiplication work is organized and controlled from Njoro and represents a considerable proportion of our efforts.

Table IV

Cereal	Varieties	Plots	Acres
Wheat	51	119	3,710
Barley	24	38	380
Oats	8	40	350
Total	83	197	4,440

The total number of varieties under multiplication was much the same as in 1954 but the acreage on the other hand increased by nearly 3,000 acres or some 200 per cent. The following notes summarize the main points of interest.

Four varieties, which had been successful in past trials, will probably be released for the coming season. Variety 356.A.2.A is a sister selection to 356.A.12.C released this season, from the cross 184.P.2.A.1.E $\times$ 192.Q.2.A.(L). It is beardless and has shown rather better strength in baking tests. However, during multiplication it rusted quite badly on some farms and its future is rather doubtful. 358.AA.5.B is the first of a new series of wheats from the cross 184.P.2.A.1.E $\times$ 294.B.2.A.3. It is a bearded variety suitable for medium altitude and has remained virtually free from stem rust in the field. 362.B.1.E.4 is also the first of a new series from the cross Equator $\times$ 294.M.7.C.6.C. It is essentially a high altitude variety showing resistance to ear rust but slight susceptibility to stem rust. It has a good erect straw and has yielded well in trials. The sister strain, 362.A.1.D.1 did exceptionally well under initial multiplication at Molo in 1952 but has not held its earlier promise so well as B.1.E.4. The present stock has unfortunately become contaminated and a clean stock is being multiplied; however this mixed stock will still be valuable and release will not be withheld.

A number of other varieties which had shown promise and which were due for release will now have to be discarded on account of rust susceptibility, in particular a group of 360 derivatives (360.E.13.C.6.D, 360.F.8.D.3 and 360.F.8.X series).

Amongst other varieties of promise, mention should be made of Mida $\times$ Cadet from Ottawa, other 362 strains, Capella, 1066 selections, Nabawa $\times$ Riverina Hope, 358 series and H.305-10 from Wisconsin.

RELEASE OF NEW WHEATS

The following two new wheats were released for 1955 sowings.

354.P.3.B.2.B

A selection from the cross Warigo $\times$ Stirling, made at the Plant Breeding Station, Njoro, in 1944.

354 is a beardless, white-chaffed, white-grained variety of mid-season maturity, fair straw strength, and good baking quality. Seedling tests show it to be susceptible to K9 and K11 forms of black stem rust, but it has not been attacked in the field. The variety possesses resistance to brown leaf rust, and to yellow ear rust up to approximately 7,000 ft. in Kenya.

354 has done quite well on a field scale at Endebess, Moiben, Nakuru, Rongai and Njoro; and it should be suitable for areas between 6,000 ft. and 7,000 ft. in Kenya. It takes roughly 5-5½ months to maturity, depending on altitude and climatic conditions. In view of possible yellow ear rust damage, growing much above 7,000 ft. is not advised.

This variety likes fertile conditions for best results.

356.A.12.C

A selection from the cross 184.P.2.A.1.E $\times$ 192.Q.2.A(L), made at the Plant Breeding Station in 1944.

356 is a bearded, white-chaffed, white-grained variety of earlyish maturity, fair straw strength, and fair baking quality. It is resistant to K9-13 forms of black stem rust, but shows susceptibility to the latest form K14, and was slightly attacked (but not damaged) at Njoro in 1954. The variety possesses resistance to brown leaf rust, and to yellow ear rust up to approximately 7,000 ft. in Kenya.

356 has done well on a field scale at Nakuru and Njoro; and it should be suitable for areas between 6,000 ft. and 7,000 ft. in Kenya. It takes roughly 4½-5 months to maturity, depending on altitude and climatic conditions. In view of possible ear rust damage, growing much over 7,000 ft. is not advised.

III.—Barley

CAGE MATERIAL AND NEW ACCESSIONS

The seven crosses described in last year's report have now advanced to F_3 . Certain differences in straw and grain characteristics were observed but selection was made difficult by the wet harvest. New accessions from various sources were received and the best selected for further study. The Near East Co-operative Barley Nursery 1954/55 from the F.A.O., Rome, contained 62 varieties of which only two were kept for further tests in 1955.

BARLEYS UNDER INITIAL MULTIPLICATION

At Njoro seven barleys, mostly from the 1953/54 F.A.O. Nurseries, were selected for further trial: of these two were discarded and the varieties 9052, Frontier, Otis, Lenta and Custer harvested for possible bulking in 1956. The last-named was segregating for smooth and rough awns.

On other stations, the principal multiplications were mostly of six-row types and in general all were disappointing. For record purposes the varieties were Hannchen, Tregal, Trabout, Ray and Colville at Kitale, Velvon at Eldoret and two Spratt Archer selections at Ol Joro Orok.

VARIETY TRIALS AND OBSERVATION PLOTS

In addition to the trial at Njoro, there were also trials and observation plots at Kitale, Eldoret, Ol Joro Orok and the Kinangop.

(a) Barley Variety Trial, Njoro

(Six replications of 16 varieties in incomplete randomized blocks)

Table V

Variety	Yield (bags 180 lb./acre)	POSITION	
		1955	1954
Heimdal	9.14	1	9
No. 5	7.57	2	1
Balder	7.48	3	13
Proctor	7.07	4	5
Rigel	6.97	5	3
Kenia	6.85	6	2
Mansholts 2 R ..	6.82	7	14
Saxonia	6.46	8	16
Carlsberg	6.45	9	6
Binder	6.17	10	6
Bonus	5.90	11	10
Adliker 9	5.29	12	12
Research	4.88	13	4
Goud	4.77	14	8
Goudgerste	4.65	15	11
Prior	2.24	16	15
Mean	6.17		
Significant Differences:			
P.05	1.16		
P.01	1.54		

Heimdal significantly out-yielded the remainder. This aggressive two-row Scandinavian variety came top in the trial in 1953 and is obviously very suited to conditions in Kenya. No. 5 from Eire is another potentially useful variety, coming third, first and second respectively in the three years. Prior, the Australian two-row variety accepted up to now as the standard field and malting variety, came bottom in all three years and it is evident that far higher yielding varieties are now available for Kenya.

(b) *Barley Variety Trial, Kitale*

(Six replications of 12 varieties in randomized blocks)

Table VI

Variety	Yield (bags 180 lb./acre)
No. 5	7.14
Kenia	6.88
Herta	6.67
Ymer	5.89
Heimdal	5.28
Research	4.72
Trebi	4.58
Velvon	4.42
Trabout	4.32
Carlsberg	4.06
Prior	3.74
Ray	2.87
Significant Differences:	
P.05	0.64
P.01	0.86

Here again the more aggressive Scandinavian barleys lead the list and well out-yielded the older varieties Prior and Research and the American six-row varieties Trebi, Velvon and Trabout. This is a reversal of last season's trials when the six-row varieties yielded best. As has been stated in earlier reports a barley variety is needed in the Trans Nzoia to enable a breakaway from maize monoculture which obtains over a large part of the district. Such a variety must, however, be able to grow satisfactorily on the sandy soils of the area, be aggressive and able to compete with the heavy weed growth which is a characteristic of the Trans Nzoia. Leaf blotch (*Helminthosporium* sp.) affected all varieties more or less equally, causing premature leaf death; ear blotch was heaviest on the varieties Trabout, Velvon, Prior and Research.

In the observation and multiplication plots the best proved to be Rigel, Binder and Mansholt's two-row. The plots suffered from both *Helminthosporium* and *Rhynchosporium* attack and this, coupled with the wet harvest, resulted in grain of poor quality.

(c) *Barley Variety Trial—Eldoret*

(Six replications of 16 varieties in incomplete randomized blocks)

Table VII

Variety	Yield (bags 180 lb./acre)	POSITION	
		1955	1954
Heimdal	17.78	1	8
No. 5	17.09	2	3
Bonus	16.21	3	—
Atlas	16.11	4	—
Trebi	15.65	5	4
Proctor	15.41	6	—
Velvon	15.41	6	1
Tregal	14.77	8	4
Kenia	14.41	9	7
Carlsberg	14.36	10	9
Binder	14.08	11	2
Prior	12.33	12	6
Adliker	12.33	12	—
Goudgerste	11.73	14	—
Goud	11.32	15	—
Research	11.26	16	16
Mean	14.33		
Significant Differences:			
P.05	2.67		
P.01	3.55		

In the field the three barleys Heimdal, No. 5 and Bonus could be picked out for their better growth and thicker stands. The standard varieties, Prior and Research, are amongst the lower yielders, the latter in fact coming bottom.

(d) Barley Variety Trial—Ol Joro Orok*

(Six replications of 15 varieties in randomized blocks)

Table VIII

Variety	Yield (bags 180 lb./acre)	POSITION	
		1955	1954
Kenia	11.74	1	7
Trebi	10.93	2	1
Heimdal	9.96	3	2
Maja	9.51	4	—
Research	9.29	5	15
No. 5	9.15	6	4
Proctor	9.02	7	—
Binder	8.89	8	—
Carlsberg	8.69	9	10
Prior	7.65	10	12
Goud	7.60	11	—
Ray	7.31	12	8
Velvon	7.11	13	3
Herta	6.99	14	5
Standwell	5.69	15	13
Mean	8.63		
Significant Differences:			
P.05	1.94		
P.01	2.56		

*A similar trial at the Kinangop was destroyed by hail.

It will be seen that both Trebi and Heimdal kept their top ranking positions from 1954, but No. 5 dropped slightly. Trebi has always shown an excellent yield, both in yield trials and on a field scale, but has always given grain of very low bushel weight. In view of this, and in spite of the excellent yielding characteristics, the value of this variety would appear doubtful.

(e) *Barley Variety Trial—Molo*

(Six replications of 16 varieties in incomplete randomized blocks)

Table IX

Variety	Yield (bags 180 lb./acre)
Heimdal	10.14
Carlsberg	9.81
No. 5	9.15
Proctor	8.30
Goudgerste	8.19
Goud	8.14
Rigel	8.05
Binder	7.88
Bonneville	7.07
Saxonia	6.79
Winter Club	5.51
Research	4.78
Prefect	4.10
6-Row Dense	3.68
Prior	2.41
La Prevision 19	1.73
Mean	6.61
Significant Differences:	
P.05	1.86
P.01	2.48

This is the last of this season's barley trials, and again shows the superiority of the Scandinavian types over the established varieties, Research and Prior, and the six-row types.

BARLEYS UNDER FIELD MULTIPLICATION

These were mostly of the two-row Scandinavian type, which has proved so successful in earlier trials. Two of them, Carlsberg and Proctor, are now in sufficient quantity for release in 1956. Heimdal and No. 5, two further varieties of the same type have already been noted as showing considerable promise as being of very strong growth and high yield. The latter contains some Archer blood in its parentage and, like Proctor, may have value for malting. The remaining barleys now seem less attractive in the face of competition from these Scandinavian types and, with a state of saturation having nearly been reached, it seems unlikely that others will be released for the time being. One possible exception is Prefect, a six-row winter type for use as feed in the high country where it has shown up well in preliminary trials.

RELEASE OF NEW BARLEYS

No barleys were released during the year under review.

IV.—Oats

The work with oats is confined to the testing of introduced varieties, and no hybridization work has so far been carried out. The market for oats in Kenya is very limited and a breeding programme is not really justified. In view of the fact that there are a number of promising oats already under trial, no new accessions or initial multiplication plots were grown.

VARIETY TRIALS AND OBSERVATION PLOTS

Trials and observation plots were put down at Eldoret, Kitale, Ol Joro Orok, the Kinangop and Molo. The trial at the Kinangop was destroyed by a severe hail storm.

(a) Oat Variety Trial—Eldoret

(Six replications of 21 varieties in incomplete randomized blocks)

Yields were very low due to the wet harvest and ranged from 5.9 to 0.9 bags per acre. No significance was reached and details will be omitted. The variety R.L.1734 from Canada which came third in 1954, heads the list this season; it is ready for release in 1956.

(b) Oat Variety Trial—Kitale

(Six replications of 10 varieties in randomized blocks)

The trial failed due to heavy stem rust attack, followed by lodging and weather damage at harvest. Cedar and a Landhafer cross gave a small quantity of grain solely because they lodged and shattered least.

(c) Oat Variety Trials—Ol Joro Orok and Kinangop

(Six replications of 13 varieties in randomized blocks)

Both these trials were destroyed by the wet harvest and nothing of any value obtained.

In the observation plots at Ol Joro Orok, 19 varieties were put down for study. All, except one, were badly attacked by stem rust, lodged and were abandoned. The single exception was Zephyr which remained standing and produced worthwhile grain. It will be carried on in 1956.

On the Kinangop, the varieties Boone, Tama, Andrew, Ajax 1948 and (Mindo × Hajira—Joanette) × Landhafer proved the best grown and suffered least from the wet harvest and rust attack. The remainder rusted and lodged.

(d) Oat Variety Trial—Molo

(Four replications of 13 varieties in incomplete randomized blocks)

Much shedding took place towards harvest due to the high winds which are characteristic of the area in the dry season. As a result yields were low and the trial did not reach significance. The varieties Vikota, Fultex and Orient were some way ahead of the remainder in yield.

OATS UNDER FIELD MULTIPLICATION

Six varieties were multiplied during the season, R.L.1734, Boone, Tama, 3003.F, Cedar and Vichland. R.L.1734 again yielded well in the lower country. It stands well and possesses good, strong straw. It has proved itself a reliable yielder over the period of its trials and multiplication, and will especially provide a valuable variety for the sandy soils of the Trans Nzoia where oats are not usually successful. It will be released in 1956.

Boone and Tama grew very well and showed extremely aggressive growth in the high country of the Kinangop but as with all cereals in the area they suffered badly from the wet harvest. However, it is likely there will be a sufficient quantity of Boone to release for 1956 sowing. Tama will have to be multiplied for a further season.

RELEASE OF NEW OATS

The following variety was released for 1955 sowings.

Vikota

A direct importation from the United States of America, received at Njoro in 1948.

Vikota is a short-strawed, white-husked variety of earlyish maturity. It has shown satisfactory field resistance to disease, particularly stem and leaf rusts. It has done well on a field scale at Kitale and Eldoret, and in the higher country in smaller scale tests. It should be suitable for areas between 7,000 and 9,000 ft. in Kenya having adequate rainfall. It takes roughly five months at 7,000 ft. and rather more in the higher areas.

Vikota is a grain oat rather than a hay or silage type, but the variety is unacceptable for porridge purposes on account of a peculiar taint in the product.

V.—Maize

General maize breeding continued at Njoro and Kitale, and special breeding for resistance to *Puccinia polysora*, begun in 1953, was undertaken at Kwale in Coast Province.

A.—GENERAL BREEDING WORK

The drought in June-July held up the growth of maize both at Njoro and Kitale, but no actual damage was suffered. This drought and the prolonged rain at the end of the year resulted in an exceptionally long season. However, sets of seed were particularly good at Kitale and both programmes made useful progress. A larger programme was undertaken at Kitale than previously as a Plant Breeder arrived in July to take over and expand the work there. The main programme will now be centred at Kitale rather than Njoro.

A new line of work was the participation in co-operative maize trials organized on an interterritorial basis by the Specialist Committee on Agricultural Botany. Of a total of 11 such trials in East Africa four were under the control of the Department of Agriculture for Kenya (namely at Njoro, Kitale, Machakos and Matuga) and the results are briefly reviewed later in this report.

Njoro

The programme consisted of three sections. Of the 13 pre-war inbreds only six had seemed pure last year and it was therefore essential to cease further crossing and concentrate on their purification. These inbreds have had a very chequered history and it is clear that they have suffered badly from the effects of the droughts and other misfortunes of recent years. In 1955 there were 19 sub-selections and 15 bulk stocks of these inbreds. Extensive selfings were carried out as the basis for a further series of cob row selections in 1956, and it should then be possible to decide on the future use of this material.

There were 182 selections of more recent inbred lines. All of these were white types, yellows having been held in abeyance. These selections ranged from S_7 to S_{22} , of which 70 were derivatives from Njoro maize, 54 from other Kenya maize and the remainder from imported varieties. This latter group consisted mostly of quicker types than Njoro maize and these have been maintained for transfer to Machakos as the starting point for the work due to begin there in 1956-57.

The first synthetic was multiplied on a field scale at Egerton College on 16 acres and yielded at the rate of 15 bags per acre (200 lb. net). After careful selection the quantity of seed for issue was about 50 bags. The synthetic was a little earlier than the College maize, more even and had better covered tips. In the crib, the cobs were more regular for type and showed less disease. It is therefore hoped that this synthetic will prove valuable.

Breeding policy has now changed to greater emphasis on the development of self-propagating maize rather than hybrids, and accordingly a further range of 137 S_1 lines was grown in 1955 for top-crossing. In this case the tester was the first synthetic and, after trial of the top-crosses in 1956, the best lines will be compounded as a second synthetic, complementary to the first.

Kitale

The scope of the work was essentially similar to that at Njoro. The old inbreds were sown as 83 cob selections and considerable time was devoted to a critical assessment of their characters and purity. The conclusion was that all these 11 are now more or less contaminated and considerable repurification is needed during the next two seasons. A triple lattice trial of the 45 single-cross combinations of ten of these inbreds was not successful, due to poor stands and uneven soil fertility. There were six which yielded slightly higher than the control, but no statistical significance can be given to this result.

The range of top-crosses of various lines under trial in 1954 was somewhat reduced and a retrial of 64 entries was laid down in a triple lattice design. Again, this failed to achieve significant results. It is apparent that effort must be devoted to improving the efficiency of maize trials at Kitale; in particular to overcoming the very strong fertility difficulties caused by the numerous ant hills in the land there.

The first Kitale synthetic was given its initial multiplication on the station and yielded at just over 16 bags per acre from one-third of an acre. This yield was rather better than that of the station maize, and the cobs tended to be fatter and have more rows of grains. For 1956, the amount of selected seed will be sufficient to sow 18 acres on the station and 25 acres with a local farmer. This first Kitale synthetic is now being followed, as at Njoro, by a programme to develop a second; accordingly some 200 original selfings were carried out on selected plants in the best station maize. The set of seed was poor and only 80 S_1 's were selected for top-crossing in 1956. These will be crossed with the synthetic as the tester so that in due course a second synthetic may be made.

CO-OPERATIVE TRIALS

These trials were organized as a means of examining a range of 13 differing East African maize stocks for their potential value as breeding material. These trials will be reviewed elsewhere, but it is desirable to record here our participation in the project and quote certain of the data.

The trial at Machakos was killed by drought and those at Njoro and Kitale were delayed in reaching maturity for reasons mentioned earlier. The following table shows the adjusted yields and positions at Njoro, Kitale and Matuga.

Table X

Variety and Origin	NJORO		KITALE		MATUGA	
	Yield	Position	Yield	Position	Yield	Position
Flat White (Njoro) ..	20.01	1	16.70	2	2.74	11
Flat White (Kitale) ..	14.48	3	19.05	1	2.95	10
Katumbili (Nachingwea)	5.47	10	13.20	7	3.98	3
Katumbili (Namulonge) ..	4.61	11	7.14	11	3.51	7
Katumbili (Mwanza) ..	5.88	9	8.71	10	4.49	1
Katumbili (Kilosa) ..	4.34	12	4.65	12	3.15	9
Muratha (Namulonge) ..	9.02	7	9.89	9	1.41	13
Muratha (S.A.L.) ..	8.37	8	11.97	8	2.60	12
Yellow (Rongai) ..	16.09	2	14.64	4	4.43	2
Ulu (Namulonge) ..	11.62	5	14.58	5	3.67	6
Nyanza (Bukura) ..	10.69	6	14.77	3	3.81	4
Hickory King (Kitale) ..	11.93	4	14.04	6	3.68	5
K 8 (Kawanda) ..	2.48	13	1.61	13	3.24	8
Mean	9.62		11.61		3.35	
Significant Differences ..	2.25		2.85		1.37	
	3.04		3.84		1.85	

(Yield expressed in bags of 200 lb. net per acre)

The results at Njoro and Kitale are broadly similar, as would be expected, and demonstrate the obvious superiority of the home varieties followed by other Kenya maizes of the long term type. This result confirms that other East African maize stocks do not offer general points of value to the breeding of improved maizes for the Highlands of Kenya. Accordingly it was decided that Njoro and Kitale will be omitted from the 1956 series of these trials. At Matuga it was noted that the slower types were unable to mature in the short season.

In addition to the yield data quoted above, a considerable amount of special data of interest to breeders was recorded and it is hoped that these co-operative trials will provide useful fundamental information for breeding programmes in East Africa.

B.—PUCCINIA POLYSORA

The work to transfer resistance to *P. polysora* into local maize continued during the season. The source of resistance consists of lines from Central America (mostly from Columbia) and recurrent back-crossing has been carried out using improved material from E.A.A.F.R.O. having a high proportion of resistant plants. On the results of last season the programme was divided into two sections (1) selfing in crosses which had shown promise, to obtain resistant lines; and (2) further back-crossing of selected progenies to local white maize. It was decided to move the work from Kibarani at sea level to Kwale at 1,200 ft., since the latter has a more plentiful and reliable rainfall. The season was a good one: *P. polysora* appeared early in the breeding plots, and spread well in susceptible material.

In 1954 considerable difficulty was experienced in grading plants into differing degrees of resistance to the disease. Accordingly, it was decided to adopt a simple "presence or absence" basis of grading this season. All plants showing any pustules of rust, regardless of whether the sori were of the "open" or "closed" type, were regarded as susceptible; only plants showing complete absence of infection were classed as resistant. This method has certain disadvantages in theory but it was

found to work well in practice. As the *polysora* programme is conducted some 400 miles from Njoro, and by an officer who is not primarily a plant breeder, the advantage of such simplified classification needs no emphasis.

The present season's programme consisted of further selfing in selected progenies from eight crosses comprising AFRO lines 24, 29 and 30 crossed with Local White, Yellow Coast, Katumbili and Nyanza. Best plants in selected rows were selfed, and those showing resistance to *P. polysora* were harvested. Since *polysora* had not appeared in the plots at the time of selfing, a number of cobs in other rows were selfed in case the selected rows should subsequently prove fully susceptible.

Seedling tests carried out by Dr. H. H. Storey, of E.A.A.F.R.O., show a useful proportion of homozygous resistant lines. These will be sown in a polycross plot in 1956 to provide a bulk of resistant material for first issue. The best segregating progenies will again be selfed in 1956 to extract further pure breeding lines.

In the crossing block, 59 selected cob rows from 13 crosses were again crossed to local maize to give the second back-cross. The original material comprised the AFRO lines 24, 29 and 30 crossed by Local White, 90-day, Muratha, Yellow Coast, Durum, K8, Nyanza and Katumbili. Lines showing vigour of growth equal to local maize were found in the cross AFRO 24 $\times$ Local White and AFRO 24 $\times$ Yellow Coast; excellent cobs were produced from the crosses AFRO 30 $\times$ Nyanza and AFRO 30 $\times$ Muratha. Crosses showing a high proportion of *polysora*-resistant plants were AFRO 29 $\times$ Durum, Yellow Coast and Katumbili, and AFRO 30 $\times$ Nyanza and Muratha. Resistant plants were harvested and selected cobs in this material will again be crossed to local maize in 1956 to give the third back-cross.

The programme has now reached the stage when the first pure-breeding resistant lines are available and these are to be multiplied in a suitable form for issue. In the meantime work will continue to produce further resistant material with a greater degree of adaptation to local conditions.

VI.—Experimental Work

WHEAT QUALITY INVESTIGATIONS

There is little doubt that the baking quality of wheat in Kenya has steadily declined over a period of years. This decline is due both to a decrease in protein content and quality but lack of quality appears to be a factor of greater importance than lowered content. In general, new varieties have initially shown satisfactory quality but have subsequently deteriorated. Several reasons have been advanced to account for this: (a) deterioration in soil fertility due to wheat monoculture; (b) disbalance between the uptake of nitrogen and phosphorus, contingent upon the increased use and heavier applications of phosphatic fertilizer; and (c) loss of inherent characters by genetic break-down or by contamination.

Accordingly, the work started in 1954 in co-operation with E.A.A.F.R.O. and the millers, Unga Ltd., was considerably expanded and extended in scope. The following experiments were laid down to investigate these questions:—

- (a) A 4 $\times$ 3 $\times$ 2 trial at Molo and Rongai with four levels of phosphate, three varieties and two levels of nitrogen. The main object of this trial was to test the possibility of phosphate influencing nitrogen uptake and protein content.
- (b) A 4 $\times$ 2 factorial trial at Eldoret, Ol Joro Orok, Molo and Kinangop using one variety and applying nitrogen at various stages of plant growth combined with two levels of basal phosphate application. The main object of this trial was to determine the effect of nitrogen top dressings on protein content.

- (c) A $7 \times 2 \times 2$ trial to observe the effect of different environmental conditions on quality over several seasons. Seven varieties were used at the same four sites as in (b) above, covering the main wheat ecological zones in Kenya. Uniform seed of each variety from the same source was used at each site. Adequate seed has been stored so that after the first year half the plots can be sown with the original seed and half with the seed harvested from the previous crop, giving a direct comparison between new and old seed. A basal dressing of phosphate was given to the experimental area and the plots split for nitrogen top dressing. Owing to the poor season and severe rust attack on most varieties, the trials were not as successful as had been hoped.

VII.—Publications

1. H. C. Thorpe and G. E. Dixon, "Release of New Cereal Varieties—1955". *East African Agricultural Journal*, January, 1956.
2. H. C. Thorpe, "Cereals in Kenya—1955/56". *K.I.O. Fortnightly*, February, 1955, and local Press.
3. H. C. Thorpe, "Synthetic Maize". *K.I.O. Fortnightly*, March, 1956, and local Press.
4. H. C. Thorpe and A. D. S. Duff, "A note of the Appearance of two New Stem Rust Forms in East Africa". *East African Agricultural Journal*, July, 1955.
5. A. D. S. Duff and J. A. Gilmour, "The Treatment of Loose Smut of Barley in Kenya". *East African Agricultural Journal*, April, 1955.
6. A. D. S. Duff, "Resistance to Take All Disease in Kenya Wheat 131—II". *East African Agricultural Journal*, July, 1955.
7. Papers entitled, "*Puccinia polysora* in Maize—Progress Report III", by H. C. Thorpe, and "Co-operative Maize Trials—1955", by G. E. Dixon, were presented to the meeting of the Specialist Committee on Agricultural Botany at Kawanda.

VIII.—Acknowledgments

Acknowledgment is again made to Messrs. Unga Ltd., for baking tests carried out by their Chemist, Dr. A. H. Woodhead, and to Mr. K. Howes, Field Officer, for crop statistics; and to Dr. H. H. Storey, F.R.S., and Dr. H. F. Birch, of the East African Agricultural and Forestry Research Organization for valuable help with the maize *polysora* work and soil problems.

Thanks are given to other sections of the Department for help during the season, especially to the District and Experimental Officers who have carried out much useful work in support of our programme; and to my staff for loyal support during the year.

The co-operation of overseas workers who have sent breeding material and advice is also gratefully acknowledged.

H. C. THORPE,
Senior Research Officer (Plant Breeding).

ANNUAL REPORT—ENTOMOLOGIST, (COFFEE SERVICES), 1955

LEAFMINERS, *Leucoptera coffeella* Guer and *L. coffeina* Washb.

Work on leafminers has been mainly directed towards trials of insecticides as foliage sprays with a view to controlling the larvæ within their mines. Insecticides tried to date have been mainly those reputed to combine low mammalian toxicity with a short residual effect.

An experiment to compare the value of malathion and diazinon at 0.1 per cent active ingredient, gave the following results against the larvæ:—

Weeks after Treatment					NUMBERS OF PUPAE FROM 300 LEAVES		
					Control	Malathion	Diazinon
1	..	..	..	..	81	48	4
2	..	..	..	..	77	46	3
3	..	..	..	..	40	8	1
4	..	..	..	..	45	20	5
5	..	..	..	..	36	81	4
6	..	..	..	..	34	42	13
7	..	..	..	..	38	34	40

The insecticides were applied with hand-sprayers at a rate of one pint of diluted material per tree on single plots, each of 16 trees. Other experiments done subsequently, using more elaborate layouts showed diazinon to be the most efficient insecticide. Control of larvæ was achieved with a diazinon concentration of 0.05 per cent. It has, however, been difficult to make recommendations to planters because it is not yet possible to forecast outbreaks. In many cases, potential outbreaks were controlled by the considerable parasite complex associated with these insects.

Investigations are being continued on the parasite complex and any insecticide likely to show promise.

COFFEE BERRY MOTH, *Thliptoceras octoguttale* Feld.

This insect was more prevalent than usual on many estates, probably because of abundant food material provided by a heavy crop. Damage done was occasionally more serious than usual, possibly due to climatic factors affecting the efficiency of parasites which normally keep it in check. It did not become a pest of major importance.

LEAF-EATING CATERpillars, *Parasa vivida* Walk. and *Niphadolepis alianta* Kersch.

Damage was done by both species to coffee foliage in the Central Province in the first half of the year.

Control of outbreaks was achieved by D.D.T. sprays, using D.D.T. at 0.1 per cent concentration. Useful alternative methods of control were pyrethrum powder

dusting at rates as low as 4 lb.-5 lb. per acre against *P. vivida*. *N. aliata* was controlled on an estate in the Donyo Sabuk district with a 5 per cent D.D.T./diatomite dust applied at 30 lb. per acre with a tractor-mounted dusting machine. If an outbreak is treated before serious defoliation occurs, such dusting methods are extremely efficient against these insects.

COFFEE THRIPS, *Diarthrothrips coffeæ* Williams.

No widespread outbreak of thrips occurred, but control measures using D.D.T. at 0.1 per cent concentration, were taken on many estates in the Ruiru/Thika area.

Opportunity was taken to try diazinon against this insect at the Coffee Research Station. Plots of 25 trees were sprayed with diazinon at the concentrations, and with the results shown below:—

Treatment	NUMBER OF THRIPS PER 100 LEAVES. (AVERAGE OF 2 PLOTS)				
	Before Spraying	Days after Spraying			
		1	3	6	10
Diazinon 60% emulsion diluted 1 part per—					
1,000 parts of Water	219	13	11	19	139
2,000 parts of Water	178	17	13	38	243
3,000 parts of Water	203	46	61	59	88
Control(not Sprayed)	55	47	56	58	66

As the insecticide is not persistent, the populations were not held at a low level for a sufficient length of time.

ANTESTIA, *Antestiopsis lineaticollis* Stal and sub-species

Serious outbreaks of antestia, mainly *A. lineaticollis*, occurred in the Central Province in the latter part of the year, coincident with the ripening of the crop. The abundant food material available to the insects enabled them to breed at an enhanced rate.

Experiments against antestia were done with pyrethrum dust formulations, emulsions of D.D.T. and pyrethrum applied from aircraft and emulsions of pyrethrum applied by tractor-drawn machines.

These experiments are reported below:—

(1) *Pyrethrum Dust Formulations*

Pyrethrum dusts of various compositions were supplied by the Pyrethrum Board of Kenya for trial against antestia.

They were tried against *A. lineaticollis* on an estate in Kiambu. All were applied by hand at a rate of 10 lb. per acre. The experimental layout consisted of two randomized blocks, and the figures shown are averages of four plots:—

Treatment	AVERAGE NUMBERS OF ANTESTIA PER TREE		
	Before Dusting	Days after Dusting	
		1	3
1. Unselected normal quality pyrethrum powder	8.4	1.0	1.9
2. Unselected normal quality pyrethrum powder diluted to a 1 per cent content of pyrethrins with ground limestone ..	6.6	0.8	3.3
3. As No. 2, but with 0.5 per cent piperonyl butoxide added ..	8.3	0.4	1.3
4. 80 per cent ground limestone, 20 per cent pyrethrum marc containing 0.2 per cent pyrethrins and 2 per cent piperonyl butoxide.. .. .	6.2	0.6	0.5
5. Control. Not dusted	7.5	8.0	4.1

Statistical analysis showed no significant difference between the performance of these materials against antestia. Formulation No. 4 above, has now been recommended for use against antestia as it is cheaper than pyrethrum powder. Planters who have used it to date, though not yet very many, have been satisfied with its performance. If this is borne out by experience in future, the material will supplant the pyrethrum powder hitherto used for control of antestia. Close liaison with the Pyrethrum Board of Kenya is being maintained with a view to improving the formulation of the material.

(2) *Emulsions of D.D.T. and Pyrethrum Applied from Aircraft*

An experiment to assess the effect of these materials applied from aircraft over shaded coffee, demonstrated that they were ineffective where the aircraft was forced to fly high over the coffee by the presence of shade trees.

(3) *Pyrethrum Concentrate Emulsions Applied by Airblast Tractor-drawn Machine*

Emulsions of 25 per cent w/v pyrethrum extract, and a 5 per cent synergized pyrethrum extract were applied with an air-blast machine delivering 60 gallons of diluted material per acre.

In no instance was any worthwhile control of antestia achieved: this is thought to be due to an unsuitable droplet size emitted by such a machine for this particular purpose. The results were in direct contrast those achieved by hand spraying similar material, detailed in the 1952-54 report.

WHITE BORER, *Anthores leuconotus* Pasc.

An experiment was started in Makuyu using the dieldrin spray-banding technique used against this insect in Tanganyika. The first application was carried out in November, before the onset of the short rains. Careful counts of boring larvæ are being done twice per year in the treated block. Some growers have adopted the method on their own initiative, thus providing a larger area in which general observations can be made. Should the method prove effective under the conditions found in Kenya, a great advance in the control of the insect will have been achieved.

General

The coffee mealybug, *Planococcus kenyæ* Le Pelley, caused very little trouble during the year. This had undoubtedly been due to the efficient control of the attendant ant, *Pheidole punctulata* Mayr., achieved by spray-banding with such materials as dieldrin and chlordane whenever incipient outbreaks were seen.

Tip-stem borer continued to be troublesome in the higher parts of Kiambu, but it was not possible to carry out any major investigations on this pest.

D. J. McCRAE,
Entomologist (Coffee Services).

REPORT OF THE AGRICULTURAL OFFICER (COFFEE SERVICES) FOR THE YEARS 1954 AND 1955

Cultivation Trial

In January, 1952, after the trial had been operating for five years, the treatments were modified and the scope of the trial was reduced to six replicates of a 3×3 design to test the factorial combination of the following treatments:—

(a) *Three Types of Implement*:—

Hand-fork, disc harrow and disc plough, used to a depth of 3 in.–4 in.

(b) *Three Weed Controls*:—

(1) Clean weeding.—Weeds controlled whenever necessary during the rains.

(2) Slashing.—Weeds slashed whenever necessary during the rains.

(3) Tall Weeds.—Weeds not controlled during the rains.

In all three treatments weeds were turned in at the onset of the dry season. Each of the 54 main plots were split for assessing the effect of one *debe* (four-gallon tin) of boma manure per tree, applied just before the long rains. In effect, therefore, the depth of tillage contrasts and the subsoiling treatments were discarded; the experiment was also reduced in size by a third, to 54 plots. Following the 1951 crop, conversion to a new cycle of multiple-stem was commenced by removing two of the three heads, cutting up the third, and selecting three suckers per tree. The trial was continued without alteration during 1954; the effects of treatments on the crop yields are given in Table I below:—

Table I.—Yield Summary—in cwt. of Clean Coffee per Acre

1954 Crop	Clean Weeded	Slashed	Tall Weeds	Mean Yield
Hand-fork	17.53	13.39	11.82	14.25
Disc harrow	14.95	13.64	11.97	13.52
Disc plough	14.59	13.45	10.69	12.91
Mean yield	15.69 (100%)	13.49 (86%)	11.49 (73%)	13.56

Least significant difference.

P=0.05

P=0.01

For marginal means

0.86

1.15

Within the table

1.49

1.99

Table II.—Response to Boma Manure (C)

Main treatment	Without C	With C	Response C-(t)
Hand-fork	13.93	14.56	+0.63
Disc harrow	12.95	14.09	+1.14*
Disc plough	12.84	12.98	+0.14
Clean weeded	15.70	15.68	-0.02
Slashed	12.91	14.07	+1.16*
Tall weeds	11.11	11.87	+0.76
Mean Yield	13.24	13.87	+0.63*

Least significant difference

P=0.05*

P=0.01**

C-(1) } Within the table

1.02

1.35

only } For mean yields

0.59

0.78

From the yield differences in Table I it is clear that weed competition affected production to a substantial degree. When weeds were allowed to grow unchecked during the rains there was an adverse effect for all three implements, whereas a significant difference between clean weeding and slashing occurred only on the hand-forked plots. Clean weeding with hand-forks led to appreciably higher yields than any other treatment.

A dressing of manure produced a small but significant increase in the mean yield, but only when plots were slashed or weeded by disc harrow was the dressing responsible for higher yields. A similar pattern in respect of main treatments is evident in Table IV, although in 1955 the level of response was greater.

Immediately after the 1954 crop harvest the size of the trial was reduced from six to three replicates, in which the treatments were continued as before. Crop yields from the trial in 1955 appear in Tables III and IV below:—

Table III.—Yield Summary—in cwt. of Clean Coffee per Acre

1955 Crop	Clean weeded	Slashed	Tall weeds	Mean Yield
Hand-fork	16.45	13.12	8.96	12.84
Disc harrow	17.22	10.93	10.42	12.86
Disc plough	16.41	14.53	10.75	13.89
Mean yield	16.69 (100%)	12.86 (77%)	10.04 (60%)	13.20
Least significant difference		P=0.05	P=0.01	
For marginal means		0.80	1.10	
Within the table		1.38	1.91	

Table IV.—Response to Boma Manure (C)

Main Treatment	Without C	With C	Response: C-(1)
Hand-fork	11.47	14.22	+2.75*
Disc harrow	11.04	14.68	+3.64**
Disc plough	12.86	14.93	+2.07
Clean weeded	16.11	17.28	+1.17
Slashed	10.52	15.21	+4.69***
Tall weeds	8.74	11.34	+2.60*
Mean Yield	11.79	14.61	+2.82***
Least significant difference	P=0.05*	P=0.01**	P=0.001***
C-(1) { Within the table	2.13	2.89	3.89
only { For mean yields	1.23	1.67	2.25

After the heavy crop recorded in 1954 yields in the following year might have been expected to drop to a lower level: contrary to expectation, yields were maintained at the same high level again in 1955. The depression in production due to weed competition was more marked and, unlike 1954, there were large responses to clean weeding with all implements. The interaction of disc harrowing with the three levels of weed control was peculiar in that slashing to control weed growth gave no apparent increase in yield. For the fork and the disc plough, however, there was a response to weed control in proportion to the rate of weed suppression.

The response to *boma* manure, as shown in Table IV, was consistent in effect, but at differing levels in the main treatments. The most marked response, when combined with slashing, is attributable to a pronounced effect of manure on the weed stand: manure produces a denser and more luxuriant weed stand, which, when slashed, constitutes an effective temporary mulch cover. The absence of any response on the clean weeded plots supports this contention. But the greater volume of weeds stimulated by manuring on the tall weed treatments would be expected to provide more intense competition for soil moisture, and thus lead to a negative response; this effect does not appear to operate however.

It is noteworthy that again in 1955 manure was most beneficial on disc-harrowed plots, but this effect needs further study to elucidate the cause.

The main effects of implements and weed control during the first pruning cycle, 1947-51, and for the first four years of the second cycle are summarized in Table V below:—

Table V.—Yields expressed as cwt. of Clean Coffee per Acre

Main effects	5 years 1947-51	1952	1953	1954	1955	4 years 1952-55	
Hand-fork	27.91	3.32	3.97	14.25	12.84	34.38	(100%)
Disc harrow	26.06	3.08	4.19	13.52	12.86	33.65	(98%)
Plough	27.64	3.16	3.91	12.91	13.89	33.87	(99%)
L.S.D's. P=0.05 ..	1.40	0.91	0.40	0.86	0.80	—	
P=0.01 ..	1.84	1.22	0.53	1.15	1.10	—	
Clean weeded	35.29	4.16	4.85	15.69	16.69	41.39	(100%)
Slashed	25.65	2.79	4.19	13.49	12.86	33.33	(81%)
Tall weeds	20.65	2.61	3.03	11.49	10.04	27.17	(66%)
Significant differences as above.							

On Clean Weeded Plots only

Hand-fork	39.14	5.03	5.17	17.53	16.45	44.18	(100%)
Disc harrow	32.93	3.44	5.11	14.95	17.22	40.72	(92%)
Plough	33.77	4.01	4.27	14.59	16.41	39.28	(89%)
L.S.D's. P=0.05 ..	2.53	0.53	0.69	1.49	1.38	—	
P=0.01 ..	3.40	0.71	0.92	1.99	1.91	—	

It is evident from the table that weed control has led to very substantial increases in yield every year, but in the aggregate yields there has been only a negligible difference between implements, except on clean weeded plots where the superiority of the hand-fork is notable.

Rotovator Trial

One clear conclusion emerging from the studies of soil and tree undertaken in the cultivation trial was that weeds should be controlled by tillage during the rains; further, that the hand-fork was superior to other implements for clean weeding, in that it resulted in higher yields and a slower rate of degradation of soil structure. Attempts with improvised implements to devise a tractor-powered implement which would simulate the action of the hand-fork, finally led to the

production of a modified rotary hoe in 1953. A resumé of the work leading to the development of this implement, and the results of the tests subsequently undertaken with it, was submitted as a Paper to the Conference on Mechanization of Agriculture, held at Entebbe in June, 1955.

Towards the end of 1953, the modified rotary hoe had successfully passed the initial field tests and was considered fit for a long-term trial, in comparison with the hand-fork, for effect on soil tilth and crop yield. The trial was sited on the former Copper Spray Trial II, where the previous yield data would permit the use of covariance analysis to lower intra-treatment variability. The treatments included were:—

Implements.—Modified rotary hoe *v.* forked hand-hoe.

Weed Control.—Clean weeding *v.* tall weeds (as in the cultivation trial).

Mulch.—No mulch *v.* an annual mulch, 4 ft. 6 in. wide, applied in March in the tree rows.

These treatments were combined in a factorial $2 \times 2 \times 2$ design of two replicates and applied to mature single stem coffee at 10 ft. $\times$ 10 ft. spacing. Much of the benefit derived from clean weeding and mulching is attributable to moisture conservation: the interaction of the two methods for moisture conservation could thus be observed.

After a year's treatment Dr. H. C. Pereira examined the effects on surface tilth by testing soil core samples for pore space, percolation and rainfall acceptance. The results showed that there was no significant difference in tilth between the two implements. These tests will be repeated during the third year of the trial.

Table VI illustrates the main effects of treatments on the first two years' yield.

Table VI.—Yield in cwt. of Clean Coffee per Acre

Treatments: main effects	1954	1955
Implement—		
Fork	1.25	16.76
Rotary Hoe	3.20	16.07
Weed Control—		
Clean weeding	1.84	17.49
Tall weeds	2.61	15.34
Mulch—		
Nil	1.49	13.93
In row mulch	2.96	18.90
Least significant differences—		
P=0.05	0.68	1.74
P=0.01	0.99	2.54

Yields were low and highly variable in 1954 and the responses are of little account therefore. In 1955, weed competition reduced yields by 14 per cent, whereas the mulch treatment raised the cropping level by 36 per cent. While clean weeding raised yields on unmulched plots, it caused no significant increase on mulched plots.

Manurial Trial I

The results up to 1953 and the alterations in treatments and design of the trial were described in the last Annual Report. In 1952 the size and scope of the trial were reduced to three replicates of a 3×3 factorial to compare all combinations of the following:—

Nitrogen: sulphate of ammonia, applied early in the long rains at nil (N_0), 1 cwt. (N_1) and 2 cwt. per acre (N_2). Cattle manure applied just before the long rains at nil (C_0), one *debe* per tree (C_1) and 2 *debes* per tree (C_2). One *debe* (=4 gal.) is equivalent in this case to approximately 4 tons per acre.

Measures towards conversion were not made until April, 1952; in that year the crop was borne on the remaining half of the single stem framework. The latter was removed after the 1953 crop which was borne again on the residual portion of the old bole and on the three young heads. In the following two years crop was produced by the three stems which were in full bearing during the period. In both years there was a consistent response to the heavier dressing of nitrogen, as shown in Table VII:—

Table VII

					1954	1955
Nitrogen—						
N_0	..	..	..	..	5.58	12.42
N_1	..	..	..	..	5.91	12.40
N_2	..	..	..	..	7.11	13.92
Least significant differences—						
P=0.05	..	..	..	..	1.07	1.45
P=0.01	..	..	..	..	1.48	2.00

In neither year was there any significant response to dressings of cattle manure, but it is pertinent to record that the manure used was still unprotected from the deleterious effect of sun and rain during the process of composting on hillside stages.

Table VIII.—1953–54–55 Aggregate Yields—cwt. of Clean Coffee per Acre

Nitrogen					CATTLE MANURE			Mean
					C_0	C_1	C_2	
N_0	..	..	..	..	26.99	29.22	29.50	28.57
N_1	..	..	..	..	28.42	28.71	27.18	28.11
N_2	..	..	..	..	32.28	30.90	29.95	31.04
Mean	..	..	..	..	29.23	29.61	28.88	
Least significant differences						P=0.05	P=0.01	
For marginal means						1.98	2.72	
Within the table						3.42	4.72	

From the table it is evident that nitrogen, at the N_2 level, increased yields by $2\frac{1}{2}$ cwt. and 3 cwt. per acre. The depressive effect of cattle manure on nitrogen response was again recorded: when combined with cattle manure, there was no increase in yield, but nitrogen alone raised the yield by over 5 cwt. per acre. A negative interaction of manure on nitrogen has been observed in previous yield data of the trial.

Manurial Trial II

This trial has been reported annually since its inception in 1950. Crop responses for the past six years are summarized in Table IX below:—

Table IX.—Yields in cwt. of Clean Coffee per Acre

Treatments		Total of 4 years: 1950-3	YEARS		Total of 6 years: 1950-5
			1954	1955	
Nitrogen: Sulphate of ammonia—4 cwt. per acre	Nil +N	28.05 32.88	2.35 3.73	15.17 19.45	45.57 56.06
Mean response to N — % ..		+17.2	+58.7	+28.2	+23.0
Phosphate: double superphosphate—2 cwt. per acre	Nil +P	31.25 29.68	3.13 2.94	17.38 17.24	51.76 49.86
Mean response to P — % ..		-5.0	-6.1	-0.8	-3.7
Cattle manure: at 14 tons per acre.	Nil +C	30.18 30.75	3.10 2.98	16.77 17.84	50.05 51.57
Mean response to C — % ..		+1.9	-3.9	+6.4	+3.0
Least significant differences—					
P=0.05		2.10	1.41	1.33	3.25
P=0.01		3.11	2.09	1.97	4.81

In 1954, an apparent response to nitrogen failed to attain significance. In the following year a response of lesser relative proportion was very highly significant. In this instance the conversion of the difference into terms of percentage response is misleading. In three of the six years substantial and profitable increases in yield have been obtained by application of the equivalent of 92 lb. of nitrogen per acre during the long rains. The aggregate increase in yield has been approximately 10½ cwt. of clean coffee, or a mean annual increment in crop of 1¼ cwt. in response to 4 cwt. of sulphate of ammonia.

Heavy annual dressings of double superphosphate and cattle manure singly, together and combined with nitrogen, have failed to affect yields in the fifth and sixth years of the trial.

Manurial Trial III

This trial was laid down in 1952 on one replicate of the original Manurial Trial I, which was reduced from four replicates to one replicate. A blanket dressing of soda phosphate and Uganda rock phosphate was applied to all plots to neutralize the possibility of a residual effect of previous phosphate dressings. At the same time all trees were converted from single to multiple stem pruning. The remaining half of the single stem framework bore crops in 1952 and 1953, and in 1953 a major portion of the crop was produced on the young multiple stem heads. Immediately after harvest the old bole was cut down to one primary and subsequent crops were obtained from the new heads.

Appreciable crop response to sulphate of ammonia dressing had been obtained in other trials by applying 2 cwt. and 4 cwt. during the long rains. In view of the mobile and transient character of nitrate in the soil, it was clear

that the question of the season in which nitrogen should be applied for best effect should be studied. This trial was designed as a 3×3 factorial with three replicates to investigate the trees' reaction to nitrogen supplement in long and short rains or in both rains. The following treatments were adopted and first applied in April, 1952.

Sulphate of ammonia at three levels.—Nil, 2 cwt. and 4 cwt per acre.

Time of application at three levels.—All N applied in the long rains, all N applied in the short rains, half applied in both rains.

Thus the relative advantage of single or split dressings in both rains could be assessed when applied at the equivalent of 46 lb. and 92 lb. of nitrogen per acre.

In 1952, crop yields were very low and variability extremely high. The yield data have been discarded on account of the interference to cropping reaction caused by conversion.

No significant response to treatments could be detected in 1953 or in 1954. In 1955, however, there was a general response to nitrogen, but no difference apparently between times of application, as shown in Table X. The aggregate yields for the three years, compiled in Table XI, show only one effect; that both 2 cwt. and 4 cwt. of the fertilizer increased the crop. No difference in time or rate of dressing is evident.

Table X.—Yields as cwt. of Clean Coffee per Acre

1955 Crop Time of application	RATE OF SULPHATE OF AMMONIA			L.S.D.	
	Nil	2 cwt./acre	4 cwt./acre	P=0.05	P=0.01
All in Long Rains ..	—	15.11	14.61	3.32	—
All in Short Rains ..	—	14.84	15.73		
Half in both Rains ..	—	15.90	15.96		
Mean yield	12.38	15.28	15.43	1.91	2.67
Mean yield as % ..	100	123.5	124.7	—	—

Table XI.—1953-4-5 Total Yields

Time of application	RATE OF SULPHATE OF AMMONIA			L.S.D.	
	Nil	2 cwt./acre	4 cwt./acre	P=0.05	P=0.01
All in Long Rains ..	—	30.67	30.70	5.20	—
All in Short Rains ..	—	31.47	32.11		
Half in both Rains ..	—	33.29	31.82		
Mean Yield	27.86	31.81	31.54	3.00	4.14
Mean Yield as % ..	100	114.2	113.2		

Table XIII.—Yields as cwt. of Clean Coffee per Acre (two years)

Mulch level All plots	RATE OF SULPHATE OF AMMONIA			
	(N ₀) Nil	(N ₃) 3 cwt.	(N ₆) 6 cwt.	
Nil (M ₀)	18.24 (1)	19.81 (1)	22.12 (1)	
3 feet (M ₁)	18.71 (1)	20.49 (2)	19.33 (2)	
4½ feet (M ₂)	17.58 (1)	21.22 (2)	24.17 (2)	
6 feet (M ₃)	16.37 (1)	20.72 (2)	20.60 (2)	
Means	17.72 (4)	20.56 (7)	21.56 (7)	
Mulched plots only				Means of N ₃ and N ₆
Placement of N	Nil	3 cwt.	6 cwt.	
Bare soil (P ₁)	—	22.32 (3)	21.98 (3)	22.15 (6)
Mulched soil (P ₂)	—	19.30 (3)	20.76 (3)	20.03 (6)
Means	17.55 (3)	20.81 (6)	21.37 (6)	
Least significant differences		P=0.05	P=0.01	
Marginal means—comparing	(4) and (7) ..	2.05	2.40	
	(7) and (7) ..	1.75	2.35	
	(3) and (6) ..	2.64	3.54	
	(6) and (6) ..	1.89	2.54	
Within the tables—comparing	(1) and (1) ..	4.63	6.22	
	(1) and (2) ..	4.01	5.39	
	(2) and (2) ..	3.27	4.40	
	(3) and (3) ..	2.68	3.60	

Examination of Table XII shows that the overall effect of mulch treatments was insignificant, but some notable individual responses appear within the table, namely:—

At M₀ there was no significant response to nitrogen.

At M₁ the N₃P₁ combination was superior to all others except N₆P₂. The effect of placement is therefore in contrast at the two levels of nitrogen.

At M₂ there was a particularly strong response to N₆P₁.

At M₃ the response pattern is consistent and only the dressings to bare soil increased yields above that of control.

In Table XIII the mean response to both levels of nitrogen is highly significant and the mean difference between P₁ and P₂ is significant; in particular, however, P₁ is greater than P₂ only for the 3 cwt. dressing.

Yield data for two years are insufficient to provide a final conclusion, but there is adequate evidence to indicate that, with between-row mulch, there is no compensating response to the heavier nitrogen dressing and that nitrogen, in the ammonium form, should be applied to bare soil within the root range of the tree.

Mulch Trial

The design, layout and results of this trial have been described in previous reports. After the 1953 harvest it was considered necessary to double the rate of application of nitrogen and cattle manure, since other trials had demonstrated that annual dressings of 23 lb. of nitrogen per acre and $3\frac{1}{2}$ –4 tons of cattle manure per acre were insufficient to affect the yields. From the 1954 long rains and thereafter, the revised treatments became the following:—

Mulching.—Napier grass mulch (in standard bands of 7 ft. width and 4 in. depth) laid to all rows between the tree lines in March, to alternate rows (to the same row every year) between the tree lines in March, to all rows between the tree lines in June, and an unmulched control.

Cattle manure.—Nil and two *debes* per tree (7–8 tons per acre) applied in March.

Nitrogen.—Nil and 46 lb. of nitrogen per acre given in three forms, all as ammonia or as nitrate, half of each form (sulphate of ammonia and sodium nitrate).

The factorial $4 \times 2 \times 4$ design continued to be employed in an unaltered layout.

The effect of these treatments on yields is summarized in Tables XIV and XV.

Table XIV.—Yields as cwt. of Clean Coffee per Acre

	1954	1955	2 years' Total
(1) Mean response to mulching—			
All row mulch—March	17.35	5.95	23.30
Alternate row mulch—March	15.37	8.46	23.83
All row mulch—June	17.94	6.60	24.54
Control—no mulch	11.30	11.74	23.04
Least significant differences—			
P=0.05	1.18	1.48	1.88
P=0.01	1.59	2.00	2.54
(2) Mean response to manure—			
Cattle manure at 7–8 tons/acre	15.70	8.54	24.24
Control—no manure	15.27	7.83	23.10
Least significant differences—			
P=0.05	0.84	1.05	1.33
P=0.01	1.13	1.41	1.80
(3) Mean response to nitrogen—			
46 lb./acre of N as NH_3	15.10	9.19	24.29
46 lb./acre of N as NO_3	16.38	8.42	24.80
46 lb./acre of $\text{N}-\frac{1}{2}$ as NH_3 , $\frac{1}{2}$ as NO_3	15.40	8.15	23.55
Control—no nitrogen	15.07	6.98	22.05
Least significant differences—			
P=0.05	1.18	1.48	1.88
P=0.01	1.59	2.00	2.54

Table XV.—Total Yields of two years (1954–55) as cwt. of Clean Coffee per Acre

Nitrogen treatments	MULCH TREATMENTS			
	All row March	Alternate row, March	All row June	Control— No Mulch
46 lb./acre of Nitrogen				
All as NH_3	23.01	25.93	23.90	24.31
All as NO_3	24.62	24.23	24.40	25.93
$\frac{1}{2}$ of each	23.67	22.49	25.91	22.12
Control—No N	21.88	22.63	23.93	19.78
Least significant differences	P=0.05—3.93		P=0.01—5.30	
Cattle manure treatments—				
7–8 tons/acre	23.53	24.26	23.94	25.25
Nil	23.07	23.38	25.14	20.83
Least significant differences	P=0.05—2.66		P=0.01—3.59	

A contrast in effects between 1954 and 1955 is evident from Table XIV. All row mulches proved most beneficial in 1954, whereas the reverse was the case in the following year. The trends were so completely reversed that no differences attain significance in the two-year totals. As the mulch $\times$ nitrogen interaction table shows, only June mulching without nitrogen increased yields above the level of the controls.

There was a small gain in yield with a nitrate dressing in 1954, and a highly significant increase due to ammonia in 1955: each caused a net gain of over 2 cwt. of clean coffee in the total. Without mulch there was a substantial response to both forms of nitrogen, but no response to the two combined in a single dressing, whereas with all-row mulch in March, the reverse occurred.

In neither year did cattle manure affect the yield except in the absence of mulch: this was apparent in the 1955 and aggregate interaction tables.

The inconsistency in response to treatments which has been cited renders the results indicative rather than conclusive, until the overall effects are confirmed by future data.

Pruning Trial

Details of treatments and results of this trial have been reported annually since its inception. Since regeneration from debilitated single stem coffee in 1945, the yields from the four systems under trial have been those given in Table XVI.

Table XVI.—Yield Summary—in cwt. of Clean Coffee per Acre

Year	Multiple Stem	Single Stem (uncapped)	Single Stem (capped)	Single 2-Stem (uncapped)	Significant difference P=0.05
1946–51 6 years' total	40.12	31.46	29.40	34.86	3.50
1952 ..	0.09	3.16	2.04	1.35	1.55
1953 ..	3.04	21.06	21.35	22.13	1.80
1954 ..	13.57	1.04	0.68	0.80	1.18
1955 ..	8.24	19.83	18.85	19.32	2.43
1952–55 4 years' total	24.94	45.09	42.92	43.60	4.04

The higher productivity of multiple stem trees, which prevailed during the six years of its first cycle, was more than counterbalanced by low yields in the following two years of the second cycle. Comparison with yield records of other multiple stem trees on the estate, which were similarly treated for conversion from first to second cycle, reveals that yields elsewhere on the estate totalled 8-10 cwt. during those two years.

Since 1951, the single stem trees have become subject to a very marked habit of bearing biennially and have borne excessive crops in the odd years. These heavy crops have been of low quality, due to overbearing, and have compared unfavourably in this respect with multiple stem crops, which have been carried to ripeness without undue strain.

There is little question that, once started, the tendency to biennial bearing continues until it is checked by heavier pruning in a bearing year. Such policy will be initiated in this instance after the next harvest. The disparity which is evident in the relative productivity of the two systems between the two cycles is caused by this factor, and its detrimental effect on quality having been overlooked.

"Tonic" Copper Spraying

MACHINE-SPRAY TRIAL

A series of tests was undertaken during 1953 to determine the relative efficiency of a standard high-volume sprayer and an "air-blast" sprayer, which utilizes a low pressure of fluid and a large volume of air to carry the spray into the foliage. When tested at 60 gal. per acre, the latter machine achieved a cover of fungicidal deposit which exceeded that hitherto obtained by any other means. In comparison with a high-volume sprayer coverage was better, particularly on the inside foliage. Consequently, a long-term trial was initiated in May, 1954, to compare the two types of sprayer and their effect on yield. Using the high-volume sprayer (at the normal rate and strength of spray) and unsprayed controls as standards, the "air-blast" spray was applied at two rates and two strengths of spray.

The trial plots bore little crop in the first year when yields were not recorded. Treatments were repeated in May, 1955, and the subsequent yields recorded are shown in Table XVII.

Table XVII

		Rate— gallons per acre	Spray conc.	Cwt. of Clean Coffee per acre	Per cent of Control
"Air-blast" Sprayer ..		30	2%	10.00	330
		60	2%	10.28	339
		30	4%	10.49	346
		60	4%	8.41	278
High-volume Sprayer ..		120	2%	10.46	345
Control—no Spray ..				3.03	100
Least significant differences			P=0.05	3.93	
			P=0.01	5.44	
			P=0.001	7.52	

ANTI-LEAF-FALL TRIAL AT MAKUYU

This small trial at the North Kitito Sub-station was sprayed for the first time during 1954. In view of the difference between Ruiru and Makuyu in climate and the bearing cycle of coffee, it was considered advisable to determine the relative value of long and short rains anti-leaf-fall sprays. The trial is confined to this one aspect, sprays being of a standard 2 per cent strength and applied at one pint per tree with bucket pumps.

Yields were first recorded in 1955 and are given in Table XVIII below:—

Table XVIII

Treatments	Time of Spraying	Cwt. of Clean Coffee per acre	Per cent of Control
2 per cent spray at 1 pint per tree.	Early in Long Rains ..	6.93	152
	Late in Long Rains ..	7.83	172
	Early in Short Rains ..	5.43	119
Control—no Spray.		4.56	100
Least significant differences	P=0.05	2.45	
	P=0.01	3.52	

Yield variability was high and only the late long rains spray produced a significant response. The first year's results indicate that the optimum effect is obtained by spraying towards the end of May, a conclusion which is almost invariable in all time studies of anti-leaf-fall spraying.

SPRAY TRIAL III

From conclusions derived from the first two "tonic" copper spray trials (reported in the 1950 and 1951 Annual Reports) there arose new aspects of the problem which needed further investigation in a comprehensive field trial. Consequently, this trial was planned and laid down in April, 1951. In the treatments listed below three times of spraying were compared: a precise study of the interaction of the quantities of copper fungicide per acre, with water per acre, was believed to be the correct approach for assessing the response to variations in concentration and rate of spray for anti-leaf-fall control. The treatments applied were:—

Time of spraying.—Early in the long rains, the last third of May, early July.

Rate of spray.—One pint per tree, two pints and three pints per tree (= approximately to 54, 108 and 162 gallons per acre).

Weight of copper fungicide.—Perenox (50 per cent cuprous oxide) at 21, 42 and 63 oz. per acre.

These factors were combined in a $3 \times 3 \times 3$ factorial design of two replicates, with some of the second order interactions partially confounded. As indicated in Table XX, the combination of three rates and three quantities of fungicide produced a range of concentrations from $\frac{1}{4}$ per cent to $2\frac{1}{4}$ per cent

(equivalent to Bordeaux), although concentration *per se* was not then regarded as a primary feature of the trial. The times of spraying were based upon the progress of leaf growth and not decided by the date. In general terms the early spray was applied between 15th April and 25th April, the middle spray between 20th May and 26th May and the late spray during the first ten days of July. In 1953, sprays were delayed two weeks on each occasion by mechanical faults in the spraying machinery. Growth and leaf-fall were recorded throughout the course of the trial by individual branch counts taken fortnightly. Yield responses appear in Tables XIX and XX, in which the first year has been separated from the succeeding four years since it is a recognized fact that response to spraying occurs mainly in the following year.

Table XIX.—Yields as cwt. of Clean Coffee per Acre—Main Effects of Treatments

Treatment						MEAN YIELD	
						1951	4 years 1952-5
Time of Spraying—							
Mid April	..	..	..	..	..	10.00	32.78
End May	..	..	..	..	..	10.23	34.98
Early July	..	..	..	..	..	9.47	29.51
Spraying Rate—							
1 pint per tree	..	..	..	..	..	9.87	32.06
2 pints per tree	..	..	..	..	..	10.14	32.96
3 pints per tree	..	..	..	..	..	9.70	32.25
Copper Fungicide—							
at 21 oz./acre	..	..	..	..	..	9.55	30.41
at 42 oz./acre	..	..	..	..	..	9.68	33.27
63 oz./acre	..	..	..	..	..	10.48	33.59
Least significant difference (for each of the three sets)—							
P=0.05	..	..	..	..	..	0.85	1.95
P=0.01	..	..	..	..	..	1.16	2.65
P=0.001	..	..	..	..	..	—	3.57

Table XX.—Yield as cwt. of Clean Coffee per Acre
Interaction of rate and copper per acre

Rate of Spray pints/tree				Weight of fungicide oz./acre	Conc. equivalent	1951	4 years 1952-5
1	..	..	..	21	$\frac{3}{4}\%$	9.50	28.82
1	..	..	..	42	$1\frac{1}{2}\%$	10.29	34.47
1	..	..	..	63	$2\frac{1}{4}\%$	9.80	32.89
2	..	..	..	21	$\frac{3}{8}\%$	9.34	31.67
2	..	..	..	42	$\frac{3}{4}\%$	10.13	32.86
2	..	..	..	63	$1\frac{1}{8}\%$	10.97	34.34
3	..	..	..	21	$\frac{1}{4}\%$	9.79	30.74
3	..	..	..	42	$\frac{1}{2}\%$	8.62	32.49
3	..	..	..	63	$\frac{3}{4}\%$	10.68	33.53
Least significant differences					P=0.05	1.48	3.38
					P=0.01	2.02	4.60

The outstanding main effect appears in the time of spraying, where the middle spray is clearly superior to the other two. There was no difference between rates, but the use of 21 oz. of fungicide led to lower yield than the two higher quantities. The only significant difference among the 1951 mean yields lay in the difference between the 21-oz. and 63-oz. rates.

The interaction table shows that leaf coverage is not as important as higher concentration, that the response improves as the amount of fungicide increases, up to a concentration of $1\frac{1}{2}$ per cent at least.

Variety Trials

Two trials containing 36 varieties and selections were planted in 1950 and 1951. All crop was removed from the trees, while in the pin-head stage, during the first three years; thereafter the trees were allowed to crop freely, the level of cropping being restricted only by a standard and uniform system of cutting up. In both trials trees were trained to produce two heads for their first multiple stem cycle. A continuous mulch cover was maintained in the tree rows for the first three years and an alternate row mulch was laid between the tree rows thereafter.

Trial I included 16 selections: six from the Scott Laboratories (prefix SL) and ten selections from Kitamaiyu Estate (prefix KIT.). The latter were selected during the individual tree recording programme which was in operation in the years immediately before the war. A balanced incomplete block design was employed for testing the selections, in 20 blocks of four plots each. The aggregate yields for three years are shown in Table XXI, wherein the superiority of SL 28 and SL 19 over all other selections (except SL 14) is evident.

Table XXI.—Total Yields for 3 years (1953–4–5) as cwt. of Clean Coffee per Acre

Variety				Total Yield	Variety				Total Yield
SL 28	..	..	..	31.18	KIT 37	..	..	..	22.09
SL 19	..	..	..	30.94	KIT 107	..	..	..	21.90
SL 14	..	..	..	27.80	SL 17	..	..	..	21.52
SL 30	..	..	..	26.04	KIT 85	..	..	..	21.46
KIT 27	..	..	..	25.61	KIT 64	..	..	..	20.17
SL 1	..	..	..	24.46	KIT 106	..	..	..	19.79
KIT 251	..	..	..	23.70	KIT 145	..	..	..	19.44
KIT 13	..	..	..	22.92	KIT 109	..	..	..	19.03

Least significant difference

P=0.05 —3.92

P=0.01 —5.11

P=0.001—6.74

Trial II included 21 selections and varieties of various origins which were planted into a balanced incomplete block design of 21 blocks of five plots each. At the time of writing only the 1954 yields are available as clean coffee; these are listed in Table XXII. Since the purpose of these trials is to determine the sustained yield performance over a number of years, little weight can be attached to the results obtained during the first year.

Table XXII.—Yields in 1954 as cwt. of Clean Coffee per Acre

Variety	Yield	Variety	Yield
SL 34	12·90	M 65	7·83
Dalle Mixed	12·25	SL 28	7·23
M 83	12·04	Dilla and Alghe ..	6·89
N 218	11·66	Kenya Selected ..	5·52
N 100	10·45	Kents	5·29
M 6	10·27	M 48	5·28
SL 3	9·72	Series L	5·14
Mocha	9·40	K.P.532	5·11
SL 9	8·79	SL 18	4·74
K 7	8·54	SL 6	2·21
SL 10	8·39		

Least significant differences: $P=0\cdot05-4\cdot05$; $P=0\cdot01-5\cdot35$

For the reasons already stated above the order of productivity cannot be regarded as conclusive in either trial at this stage.

Acknowledgments

It is a pleasure to record my appreciation of the excellent work of the Assistant Agricultural Officers (Experiments), Messrs. H. H. J. de Vink and I. R. Wallace, especially to the former for the efficient manner in which experiments were continued during my absence on vacation leave in 1955.

P. A. JONES,
Agricultural Officer (Coffee Services).

REPORT FOR THE YEARS 1954 AND 1955 BY THE PLANT PATHOLOGIST AND PHYSIOLOGIST, COFFEE SERVICES

General

Although the main investigations carried out during the period under review were on problems concerned with anti-leaf-fall spraying, the continued inability to obtain special staff to work on Coffee Berry Disease necessitated the decision not to delay further, but to start investigations in their absence. A considerable amount of time was thus devoted to research on this disease.

The control of leaf rust has now become of much greater interest to planters and there is a demand for more detailed information on how best to combat this disease. In consequence a number of investigations on its epidemiology have been carried out. Further, the number of minor investigations of an *ad hoc* nature have been higher than usual. In view of the increasing amount of work to be undertaken on the pathological side, it has not been possible to devote as much time to physiological investigations as before. It is felt that the time has now arrived when these should be undertaken by a separate investigator.

In May, 1955, Mr. K. Bock was appointed Scientific Assistant in the team planned to investigate Coffee Berry Disease. In the absence of other members of the team, he worked under my direction until the end of the year, when Dr. Nutman and Dr. Roberts arrived to complete the team. Mr. Levisseur was appointed in August, 1955, as Laboratory Technologist (trainee) to help Mr. Bock with his investigations. Miss D. Napper, Senior Laboratory Assistant, left at the end of September, 1955, but was replaced by Mrs. W. Nicholls, who started work in mid-October.

The following articles have been published in the period under review:—

“The Control of Coffee Leaf Rust”, *Coffee Board Bulletin*, p. 40, February, 1954.

“Leaf Scorch following Drought”, *idem*, p. 86, April, 1954.

“Leaf Rust Epidemic Warning to Coffee Planters”, *idem*, p. 64, March, 1955.

“Anti-leaf-fall or ‘Tonic’ Spraying”, *idem*, p. 87, April, 1955.

Anti-leaf-fall Spraying

(1) FIELD TRIAL AT SOLAI

The trial is a $4 \times 2 \times 2$ factorial with four times of spraying: nil; end of May; mid-July and end of September. Sprays are applied at one and three pints per tree and at 0.13 oz. and 0.065 oz. copper per tree. There are four blocks of eight rows of 20 trees, giving two absolute replications. Spraying was carried out on 28th May, 30th July and 28th September, in 1954, and 27th May, 29th July and 21st September, in 1955. No further spraying will be carried out during 1956, but as responses are not evident until a year after the spraying, the 1956 crop will be recorded, and this will conclude the experiment.

During the two years leaf-fall continued to be recorded as previously, but observations on leaf formed after the short rains of 1954 were not made as the experiment is now being concluded.

Table I gives the 1953 and 1954 cherry and clean coffee weights.

Table I.—Yield Results of Solai Spray Trial

A.—Cherry Weights

Treatments	1953-54		1954-55		4 Years	
	lb./acre	Per cent Control	lb./acre	Per cent Control	lb./acre/year	Per cent Control
Control (T ₀)	10,362	100	3,729	100	6,067	100
May spray (T ₁)	8,886	85.75	5,968	160.1	7,491	123.4
July spray (T ₂)	10,978	105.94	4,117	111.4	6,918	114.1
September spray (T ₃) ..	7,692	72.23	5,616	150.5	7,090	116.8
2% at 1 pint (C ₁ D ₀) ..	9,359	90.32	4,977	133.4	7,103	116.9
1% at 1 pint (C ₀ D ₀) ..	8,810	85.01	5,380	144.3	6,859	112.9
$\frac{3}{4}$ % at 3 pints (C ₁ D ₁) ..	8,890	85.76	5,167	138.6	6,826	112.4
$\frac{1}{4}$ % at 3 pints (C ₀ D ₁) ..	10,860	104.80	3,906	104.7	6,779	111.7
Significant difference—						
5% point	1,444	13.93	1,556	41.9	826	13.46
1% point	2,754	26.57	2,171	58.2	1,152	18.98

Significant differences—

1953-54	1954-55	4 Years
T ₁ < T ₀ * and T ₂ **	T ₀ < T ₃ * or T ₁ **	T ₀ < T ₂ ***, T ₃ *** or T ₁ ***
T ₃ < T ₀ ** and T ₂ ***	T ₂ < T ₁ *	T ₂ < T ₃ *** and T ₁ ***
1% and $\frac{3}{4}$ % $\frac{1}{4}$ %**		T ₃ < T ₁ ***
2% < $\frac{1}{4}$ %*		$\frac{1}{4}$ %, $\frac{3}{4}$ % and 1% < 2%***

B.—Clean Coffee

Treatments	1953-54		1954-55		4 Years	
	cwt./acre	Per cent Control	cwt./acre	Per cent Control	cwt./acre/annum	Per cent Control
Control (T ₀)	13.7	100	5.1	100	8.49	100
May spray (T ₁)	11.1	80.9	7.6	150.8	9.77	115.0
July spray (T ₂)	14.0	102.4	5.3	105.9	9.12	107.4
September spray (T ₃) ..	9.9	72.3	7.7	151.8	9.76	108.4
2% at 1 pint (C ₁ D ₀) ..	12.2	89.0	6.5	127.9	9.56	112.5
1% at 1 pint (C ₀ D ₀) ..	11.3	82.8	7.2	141.8	9.22	108.6
$\frac{3}{4}$ % at 3 pints (C ₁ D ₁) ..	11.3	82.3	6.9	136.3	9.15	107.7
$\frac{1}{4}$ % at 3 pints (C ₀ D ₁) ..	13.9	101.6	5.2	101.3	9.22	108.6
Significant difference—						
5% point	2.0	14.7	1.3	26.7	0.55	6.5
1% point	2.8	20.5	1.9	37.4	0.77	9.1

Significant differences—

1953-54	1954-55	4 Years
T ₁ < T ₀ * and T ₂ **	T ₀ < T ₃ ***	T ₀ < T ₂ *, or T ₃ ***, or T ₁ ***
T ₃ < T ₀ ** and T ₂ ***	T ₀ and T ₂ < T ₁ * and T ₃ **	T ₂ < T ₃ *, or T ₁ *
1% and $\frac{3}{4}$ % < $\frac{1}{4}$ %*	$\frac{1}{4}$ % < 2%*, $\frac{3}{4}$ %* and 1%**	

The relative sizes of the 1953/54 crops for the various treatments were largely affected by the size of the previous year's crops, high cropping treatments in 1952/53, having poor crops in 1953/54. Thus in the three years the control plots have yielded 12.1, 3.1 and 13.7 cwt./acre, whereas the May-sprayed plots have yielded 12.1, 8.3 and 11.1 cwt./acre. The higher yield for the non-sprayed coffee in 1953/54 as against the May-sprayed coffee is the result of the low crop the previous year. The same applies to the significantly lower yield produced by the September spraying. The differences due to copper per tree and rate are attributable to the same effect.

With the 1954/55 crop, a positive response to spraying was again obtained, the May and September sprayings producing nearly equal increases in yield, whereas the crop from the July-sprayed plots was only slightly above that for those not sprayed. Once again there is a tendency for the higher concentrations to produce higher responses, the $\frac{1}{3}$ per cent at three pints per tree yielding significantly less than the other higher concentrations. The differences, however, are small.

Over the four years' crops, all sprays have produced significantly higher yields than control. The July spray is the least effective. The September spray appears less effective than the May spray, but it should be remembered that in 1952 it was omitted and that in 1953 all plots received a spray in September. It is therefore not surprising to find a relatively low response. The true relative status of the September spray will only appear after the experiment has been continued for say two more years. Over the four years the 2 per cent spray has shown up as very distinctly more effective than all the other sprays. The responses to spraying over the four years appear rather low, but it should be remembered that this period includes the first year when no responses were to be expected as well as the "recovery" year of 1953/54.

Both percentage A plus B Grade coffee and the weight of 500 beans have continued to be determined. As in previous years, these show little more than that the larger the crop, the less the percentage of A plus B, and the weight of 500 beans. In order to see whether there is any ameliorating effect of treatment on this relation, a covariance analysis to eliminate the effect of crop size will have to be carried out.

(2) FIELD TRIAL AT KITALE

This trial is of similar design to the Solai trial, but there are three replicates instead of two. The same rates and concentrations are used, but the times of application are mid-May, mid-June and late August. Spraying commenced in 1952. The actual dates of application for the years 1952-54 were 15th, 28th and 20th May; 17th, 30th and 29th June; and 29th, 29th and 31st August. In 1953 the May spraying was, in error, carried out at three times the correct concentrations. Two replicates have the trees spaced 9 ft. $\times$ 9 ft. and the third at 10 ft. $\times$ 10 ft. There are 15 multiple stem trees per plot and the experiment is on shaded coffee at the Kitale Agricultural Experiment Station. Yields are recorded as cherry weight only.

The results for the three crops recorded so far are given in Table II. In the first year, no responses were shown as is usual in an anti-leaf-fall spray experiment. The next year, the May spraying treatment showed a significantly higher yield and June spraying gave a small and non-significantly higher yield than control. In 1954/55, both August and June spraying showed significantly higher yields than control, whereas the May spray was also higher but just failed to reach significance. The reversal of the order of the responses due to time of spraying as compared to the previous year are, no doubt in part at least, due to

the effects of a tendency to biennial bearing. Over the three years May spraying retained its lead, the yields being 133.3 cwt./acre for control, 157.5 cwt./acre for May spraying, 152.6 cwt./acre for June and 144.9 cwt./acre for August spraying. There have been no significant effects of copper per tree or rate.

Table II.—Yield Results of Kitale Spray Trial—Cherry Weights

Treatments	1952-53		1953-54		1954-55	
	cwt./acre	Per cent Control	cwt./acre	Per cent Control	cwt./acre	Per cent Control
Control (T ₀)	45.1	100	28.8	100	49.4	100
May spray (T ₁)	45.3	100.5	49.7	129.5	62.5	126.5
June spray (T ₂)	46.7	103.7	42.9	111.9	63.0	127.4
August spray (T ₃)	46.9	104.0	37.8	98.6	70.2	142.1
2% at 1 pint (C ₁ D ₀)	48.7	108.1	43.0	112.0	60.0	121.4
1% at 1 pint (C ₀ D ₀)	45.3	100.5	39.5	103.0	60.9	123.2
$\frac{3}{4}$ % at 3 pints (C ₁ D ₁)	43.6	96.8	42.3	110.3	64.3	130.2
$\frac{1}{4}$ % at 3 pints (C ₀ D ₁)	46.4	102.9	44.0	114.8	59.9	121.2
Significant difference—						
5% point	5.9	13.1	5.2	13.6	13.5	27.3
1% point	7.9	17.6	7.0	18.3	18.2	36.8

Significant differences—

1952-53	1953-54	1954-55
Nil	T ₁ > T ₂ *, T ₀ ** and T ₃ **	T ₃ > T ₀ **
		T ₂ > T ₀ *

(3) FIELD TRIAL OF COPPER AND NON-COPPER ANTI-LEAF-FALL SPRAYS

This trial was commenced at the Coffee Research Station, Ruiru, in 1954, to test the effects of a number of anti-leaf-fall sprays on yield. The main reason for the trial was to determine whether control of leaf-fall by copper fungicide spraying produced any greater effect than if non-copper sprays or hormone applications were used to produce the same amount of leaf-fall control. In this way it was hoped to obtain information on the mode of action of the copper tonic sprays and to determine whether they act entirely through their fungicidal properties or whether there is also an effect due to their copper content. Three methods of obtaining control of leaf-fall were tried; the normal anti-leaf-fall copper fungicide applied towards the end of the rains; a non-copper organic fungicide applied several times during the rains and a hormone applied at the beginning of the leaf-fall period. The materials used were Perenox, a cuprous oxide formulation at one pint per tree at 6.8 lb. in 100 gallons concentration; "Fernide", a thiram formulation applied at two pints per tree and 3 lb. per 100 gallons concentration, and Anapal, a product containing 2 per cent alpha-naphthalene acetic acid applied at three pints per tree at a dilution to give 20 p.p.m. of active ingredient. In 1955, as the hormone spraying had given little indication of leaf-fall control in spite of two applications, a 30 p.p.m. solution of pure alpha-naphthalene acetic acid plus Agral L.N. wetter was used.

As space was available in the trial, two other treatments were included; dusting with Cuprosana and two applications of Perenox, one at the same time as the single application, and the other at the beginning of the short rains.

It is a fairly common practice to apply a second anti-leaf-fall spray at this time in the upper half of the main Kiambu area and the opportunity was taken to try a similarly-timed spray at the Research Station.

As regards dusting, this method of applying copper has some possible advantages, and queries as regards its possibilities have been received both from planters and a commercial firm. Preliminary tests of the cover produced on the under-surface of coffee leaves, using the rubeanic acid printing method, indicated that it was poor. However, as the deposit is of a totally different type from that produced by spraying, it was possible that the apparent poor cover might be due to the nature of the deposit. It therefore seemed advisable to carry out a trial on the effects on yield.

The dust was a 10 per cent copper formulation and was applied with a hand-duster as a machine-duster was out of the question in a yield trial with small line plots. Even so, guard rows on either side had to be used and also hessian screens to cut down drift. The aim was to get as good a cover with the hand-machine as with a heavy application with a power-duster. The cover obtained by a "Whirlwind" duster delivering 45–60 lb. of dust per acre and passing along every fourth row was assessed by the rubeanic acid printing method and the amount of dust required to get as good a cover on the experimental trees was determined. In 1954, the average application was in the region of 40 grams per tree. In 1955 it was decided that a somewhat better cover was required and it was increased to 60 grams. This gives approximately 40 lb. and 60 lb. per acre, which is a very heavy application when it is considered that all the dust is directed into the tree in hand-dusting, whereas in machine-dusting, much goes between the trees.

A randomized block design was used with six treatments (a control was included) and four replications. Plots consisted of single lines of 25 trees. The dates of application were:—

Fernide: 13th and 26th April and 10th May, 1954; 28th April, 17th May and 7th June, 1955.

Perenox, one application, and dusting: 21st May, 1954, and 25th May, 1955.

Perenox, two applications: 21st May and 13th October, 1954; 25th May and 12th October, 1955.

Hormone: 23rd June and 25th August, 1954; 7th June and 13th June, 1955.

Leaf-fall was recorded continuously from July, 1954, onwards, except for short breaks due to pruning, etc. The first five average trees in each plot were used and shallow saucers cleared underneath them. The number of leaves collecting in these saucers during a week were recorded.

In 1954, the control trees showed heavy leaf-fall from June to September, and a much lower level to the end of the year. Leaf-fall on the plots treated with Perenox and Fernide was considerably lower, the Fernide producing, if anything, slightly better control than the Perenox. Dusting appears to have had little effect early, but by the end of August it was depressing leaf-fall considerably and continued to do so until the end of the year, though never so much as for the Perenox and Fernide treatments. The hormone-sprayed plots showed almost identical leaf-fall to that on the control plots.

In 1955, leaf-fall on the control plots increased slightly during January and February. There was a minimum in March to June. In August to November it was heavy with two marked peaks at the beginning and again in October. It fell to a minimum in November/December with another marked peak at the end of

the year. Throughout the first half of the year the plots with two applications of Perenox gave lower leaf-fall than any of the others. With a single application, there is a suggestion of some depression in the early part of the year only. The Fernide plots behaved in the same way. The dusted and hormone-sprayed plots behaved as did the control.

In the second half of the year, the Fernide plots showed the lowest amount of leaf-fall. The Perenox and dusting treatments showed similar leaf-fall to the control in August, but thereafter considerably less. The hormone-sprayed plots showed a somewhat lower leaf-fall than control in July, but did not differ otherwise.

In general, the hormone treatment appears to have been ineffective in reducing leaf-fall in 1954 and only slightly effective in 1955. More frequent applications might perhaps have an effect.

Dusting has had a very definite effect on leaf-fall, but does not appear to be as effective as Perenox spraying. Fernide is, if anything, more efficient than the Perenox treatment and this confirms earlier findings as regards copper and non-copper fungicides. The second application of Perenox pre-short rains appears to increase control of leaf-fall in the early half of the year. Yields were not recorded in 1954, as spray trials have been found not to give yield responses in the first year. The yields for 1955 are given in Table III.

Table III—Cherry Yield Results for 1955 of a Trial on Copper and Non-Copper Fungicides and Hormone for a Leaf-Fall Control

Treatment	cwt./acre	% Control
Control (C)	88.74	100
Perenox, one application (P ₁)	97.25	149.4
Perenox, two applications (P ₂)	109.97	169.0
Fernide (F)	104.15	160.0
Dusting (D)	91.12	140.0
Hormone spray (H)	76.38	117.4
Significant difference—		
5%	11.73	18.0
1%	16.27	25.0
0.1%	22.63	35.8

Significant differences—

O < D***, P₁***, F*** and P₂***

H < D*, P₁***, F*** and P₂***

D < F*, and P₂**

P₁ < P₂*

All treatments gave higher yields than the untreated plots, but the difference in the case of the hormone treatment is small and non-significant. All the other treatments gave significantly higher yields. The Fernide treatment gave a slightly higher yield than the single application of Perenox, but the difference was not significant. It would thus appear that if leaf-fall is equally well controlled by both copper and non-copper fungicides, equal yield responses may be obtained. It would seem, therefore, that copper anti-leaf-fall sprays act, as regards yield, entirely from their fungicidal properties and not from their copper content. They remain, of course, the most satisfactory method of controlling leaf-fall. The lack of effect on yield of the hormone spray is expected in view of its observed lack

of control of leaf-fall. It was hoped to obtain extra data on the mode of action of copper sprays from this treatment, especially as regards whether it is merely the longer life of the leaf, or whether its efficiency is affected by the copper sprays. It is disappointing, therefore, that no appreciable control of leaf-fall was obtained in this experiment by the hormone treatment.

In spite of the apparently rather low efficiency of dusting as regards control of leaf-fall, it does appear that it may approach spraying as a method of obtaining the "tonic" effect. However, it must be remembered that the application of dust was a very heavy one.

The second spraying of Perenox pre-short rains has given a small but significant extra response as compared to a single spraying. Whether this was entirely due to extra "tonic" effect is arguable, as leaf rust was abundant on the plots during the short rains and the time of application of the spray is such that some control of the disease may have contributed to the effect.

(4) CONCENTRATION TRIALS

As fungicide-producing firms had expressed concern regarding the concentrations which had been advised for anti-leaf-fall spraying for cuprous oxide as against copper oxychloride formulations, it was decided that some investigation of the effect of this type of fungicide on optimum concentration should be carried out. A yield trial, although the most satisfactory, was considered to take too long and be too laborious for the purpose and in view of the close relation between leaf-fall and yields so far found, a trial of effects on leaf-fall was considered adequate. Later, it was decided to take the following year's crop at it is usually in this year that a good proportion of the information forthcoming from a spraying trial can be obtained.

The trial was on single stem coffee and the original design was factorial with four types of fungicide and control at three concentrations, 21, 42 and 64 oz. of 50 per cent copper fungicide in 40 gal. of water. Forty-two ounces was the concentration hitherto advised for cuprous oxide, and 64 oz. that for oxychlorides. The 21-oz. level was included in order to give a better chance of detecting a concentration gradient. The fungicides used were Perenox and Cupromox, which are cuprous oxide formulations, and Blitox and Cuprokylt which are oxychlorides. Unfortunately, all the treatments could not be applied in one day and heavy rain occurred after those with Perenox and Cupromox. In consequence, the design was modified so that a further Perenox treatment was applied after the rain and together with the other fungicides.

Leaf-fall was recorded by picking up leaves which had fallen into cleared saucer-shaped depressions underneath the trees once a week and counting them. Observations were made from 7th July to 8th November. The amount of foliage on the trees at the beginning of the experiment was estimated on an arbitrary scale and the results used in the covariance analysis of leaf-fall.

Examination of the variation of leaf-fall with time and concentration suggested that the relation changed in the second half of the period and so the results were analysed both for the effect on total leaf-fall over the entire period and for the two halves separately.

The results for the total period show a very significant decrease in leaf-fall due to spraying, but the overall differences between fungicide effects did not quite reach significance. However, some individual differences were significant and may in the circumstances be noted without attaching undue weight to them. These

differences were: Perenox applied after the rain was better than before (5 per cent point) and Cupromox applied before the rain was better than Perenox applied at the same time.

As regards concentration, there was no overall significant effect, but the individual fungicide response curves all show a minimum at 42 oz. per 40 gal., except for Perenox after the rains which was very anomalous, showing exceptionally low leaf-fall, lower than all other treatment combinations, for the 62-oz. concentrations. It was significantly lower than a large range of other combinations.

The results for the first half of the leaf-fall period show an overall tendency for leaf-fall to increase with increasing concentration. However, this was not statistically significant. Cupromox gave significantly less leaf-fall than all other fungicides (5 per cent point) and than Perenox applied before the rain (1 per cent point). The 64-oz. concentration of Perenox applied after the rain again gave exceptionally low leaf-fall.

In the second half of the period, the overall trend with concentration was similar to that for the entire period, except that the 21-oz. concentration produced very little control, significantly less than the other two concentrations. Post-rain Perenox at 64 oz. gave significantly less leaf-fall than all other treatment combinations.

In view of the differential effects on leaf-fall at different times, it is difficult to draw any very definite conclusions, but, except for the anomalous behaviour of the high concentration of post-rains Perenox, the concentration response curve is very similar for all fungicide types. It was decided that in view of this, there was no justification to continue to advise different concentrations for the different fungicides, but in future and until contrary evidence should occur, to advise the 42-oz. level for them all when used as anti-leaf-fall sprays.

In 1955 the crop from ten-tree plots in the experiment was recorded for cherry weight. The results indicate a general increase in response with concentration with a tendency for the latter to decrease with increasing concentration. Again, Perenox showed anomalies, this time in respect to the pre-rain spray, which showed a reverse trend to all the other sprays. The results have still to be statistically analysed.

In view of the difficulty of interpretation of the leaf-fall results for 1954 and the lack of clear-cut effects, a further trial of similar design was set up on a more even block of coffee in 1955. It will be recorded for yield next year. The leaf-fall data obtained have not yet been statistically analysed. The following trends may be noted, however. Again, there is a change in response for the first as against the second half of the leaf-fall period. In the first, leaf-fall decreased with increased concentration, the reverse of the effect observed last year. In the second half, it tended to increase with increased concentration. Over the entire period there is a tendency to an optimum at the 42-oz. rate, except with Perenox, which showed least leaf-fall at the lowest concentration.

(5) TRIALS OF POSITION OF APPLICATION OF FUNGICIDE

A repeat of the experiment described on page 74 of the Annual Report (Investigations) for 1951 was carried out in 1954. The results were similar to those of the 1951 experiment: treatment of lower, or upper plus lower, surfaces, of the leaves producing greater leaf-fall than on the control branches. The other two treatments: upper surface only, and branches only treated with fungicide were not different from control.

It would seem that by the method used, i.e. painting the leaves with fungicide, only adverse effects on leaf life are produced. In consequence, in 1955, the experiment was repeated, but using a scent spray to apply the fungicide and taking care not to get the spray on to the surfaces to be left untreated. Ten trees were used and 25 branches on each chosen at random and five of these used for each treatment. The branches were marked for the mature leaves present at the time of spraying and the number recorded. Recordings of the amount of leaf were made at fortnightly intervals and graphs drawn of the march of the percentage of the total present with time. Examination of these showed that by 7th September, there was a large treatment effect and no set of branches had a loss which had reached 100 per cent previous to this date. The percentage losses up to this date were therefore analysed and an angular transformation was employed.

The treatment in which branch surfaces only were painted showed no difference from control. Spraying of upper plus lower surfaces of the leaves showed the greatest percentage of leaf still present, statistically significantly higher than where the lower surface only had been sprayed (5 per cent point) and than all other treatments (1 per cent point). Where spraying was restricted to the lower surface, there was a higher amount of leaf than where upper surfaces alone were sprayed, but the difference was non-significant. Spraying of the upper surface alone was significantly better (1 per cent point) than where branch surfaces only were painted or control.

It would appear that considerable control of leaf-fall can be obtained when spraying is restricted to upper surfaces, though it is better for both upper and lower surfaces to be covered. This may be due to redistribution of the copper by rain. It would indicate, however, that sprays which land largely on the upper surface only, may still be effective as anti-leaf-fall sprays.

(6) INVESTIGATIONS ON SPRAYING MACHINERY

In November, 1954, I attended, by invitation, a conference convened by the Interterritorial Specialist Entomological and Insecticide Committee for East Africa. A large range of spraying machinery and apparatus was demonstrated and discussed.

During the assessment of new types of spraying machines at the Coffee Research Station, a number of comparative tests of cover obtained have been carried out. Testing consists of taking representative samples of leaves from sprayed trees and pressing the lower surfaces on to filter paper treated with rubeanic acid, when a print of the position of the copper deposits is obtained. These prints are assessed for percentage cover by comparison with a set of standard prints which have had the percentage cover estimated.

The principal machines which have been examined, were the Ransomes "Agro" and the Kent Engineering and Foundries "Autoblast 4". Both these machines rely on air-blast to carry a relatively fine spray on to the coffee bushes. The Agricultural Officer had carried out cover trials with the Agro in which it was found that very good underleaf cover was produced with relatively low rates of application. It was found that above about 60 gal. per acre, increased rate only led to small increases in cover. A yield trial was laid down to test whether responses equal to those obtained with high volume application at normal rates could be obtained with the "Agro" machine and at what rates and concentrations. The existence of this trial allowed estimates to be made of the relative cover produced by the various treatments. Prints were taken on 25th May. The results are given in Table IV. The trees were single stem.

Table IV.—Estimates of Percentage of Cover, Machine Spray Trial

	"AGRO" SPRAYER				DRAKE AND FLETCHER HIGH VOLUME
	2% Spray		4% Spray		2% Spray
	30 gal./acre	60 gal./acre	30 gal./acre	60 gal./acre	120 gal./acre
Outer leaves	19.7	22.0	9.0	13.9	14.0
Inner leaves	10.9	9.5	7.6	10.0	2.8
Average . .	15.3	15.7	8.3	11.9	8.4

It was found that the "Agro" sprayer with a 2 per cent spray produced a superior cover to the high-volume machine both at 30 and 60 gal. per acre. Further, the 2 per cent sprays produced better cover than the 4 per cent, a surprising finding, but possibly related to the greater amount of spreader in such sprays leading to greater run-off. A noteworthy point is the relatively better cover produced on the inner leaves of the bush.

The superior cover produced by the air-blast spray was thus confirmed and it remained to determine the rate at which air-blast spraying produces equivalent cover to normal high-volume spraying. A trial was carried out on single stem coffee at the Research Station in May, 1955. High-volume spraying was carried out at 120 and 185 gal. per acre. The air-blast spraying rates were 30 and 60 gal. per acre with the "Agro" machine and an "Autoblast 4" was tried at 15, 30 and 60. Hand-spraying at one pint per tree was included as a standard. Unfortunately, the area was rather sloping and it was difficult to keep the machines moving evenly. Further, trouble with the chain-drive of the "Autoblast 4" machine also upset application rates. The experiment was of randomized block design with four blocks; plots were single lines of ten trees separated by guard rows. The results for percentage cover are given in Table V.

Table V.—Estimates of percentage cover in trial of spraying machines at the Coffee Research Station

	Outer Leaves	Inner Leaves	Average
Drake and Fletcher at 120 gal./acre	4.75	1.54	3.14
Drake and Fletcher at 185 gal./acre	2.58	1.80	2.19
"Agro" at 30 gal./acre	5.74	0.65	3.19
"Agro" at 60 gal./acre	4.81	0.98	2.89
"Autoblast" at 15 gal./acre	3.07	1.34	2.20
"Autoblast" at 30 gal./acre	2.91	0.85	1.88
"Autoblast" at 60 gal./acre	3.27	1.19	2.23
Hand spray at 1 pint/tree	1.53	2.72	2.12

The only significant differences were produced by the hand-spraying, and were due to the better cover of the inner leaves which this method produces. As regards average cover of the whole bush, it is evident that no differences could be detected, the air-blast machines producing a coverage comparable to those possible with high-volume or hand application.

In view of the unsatisfactory nature in certain respects of the trial just described, a second similar trial was set up on Murera Estate, Ruiru. The coffee was multiple-stem and the area flatter and more satisfactory. The number of leaves sampled was increased to 24 inner and 24 outer per plot, only half of each leaf being printed. The results are given in Table VI.

Table VI.—*Estimates of percentage cover of Leaves in Trial of Spraying Machines at Murera Estate, Ruiru*

	Outer Leaves	Inner Leaves	Average
Drake and Fletcher at 125 gal./acre ..	7.23	4.53	5.88
Drake and Fletcher at 180 gal./acre ..	8.94	7.52	8.23
"Agro" at 16 gal./acre	7.62	5.48	6.55
"Agro" at 30 gal./acre	9.63	6.84	8.24
"Agro" at 60 gal./acre	10.49	6.58	8.53
"Autoblast" at 13-15 gal./acre	7.33	4.97	6.15
"Autoblast" at 32-33 gal./acre	6.97	5.26	6.11
"Autoblast" at 60 gal./acre	9.83	5.91	7.87
Hand spraying at 1 pint/tree	5.88	5.65	5.77

None of the differences due to machines or rates are significant. However, there are distinct trends with increasing rates for each machine and the regressions of rate on cover may easily be significantly different. These have been graphed, but it has not been possible to analyse the differences statistically yet. However, the graphs support the view that hand spraying produces around about the same cover as high-volume spraying at 120-140 gal./acre and that as good a cover can be produced by as low as 15 gal. per acre applied by air-blast; 30 gal. per acre should therefore be adequate.

Later in the year further tests of cover with air-blast machines were carried out in view of cases of very poor cover being obtained during commercial spraying. As only $\frac{1}{2}$ per cent sprays were being used as against the 2 per cent with which most tests had been carried out previously, a test was made of the apparent effect on cover estimate of this difference. It was found to be quite small and in the neighbourhood of a 30 per cent reduction. A check of whether a modified design of air-blast sprayer which was being used did not indicate that this machine was producing a poorer cover than the "Autoblast 4".

In a final test, the effect of nozzle aperture was tested. Conditions were very windy at the time and it was found that very poor cover was produced throughout, including that due to the hand-sprayer which had been included as a standard. Under these conditions, large aperture of nozzle gave somewhat better cover, due no doubt to the resulting larger size droplets having a greater terminal velocity and being less easily prevented from landing by the wind. Although no definite conclusion can be reached as to the reason for the poor cover in the commercial applications, it seems likely from the known weather conditions at the time, that wind may have been the cause of the trouble. It is recommended that spraying, especially by air-blast machines, should not be carried out under windy conditions.

(7) INVESTIGATIONS ON AERIAL SPRAYING

In co-operation with Messrs. Noon and Pearce, a number of tests of the under-leaf cover produced by aerial spraying have been carried out.

In the first test on Braemar Estate, Kiambu, an Anson twin-engined aircraft was used. It flew at 120 m.p.h. and about 10 ft. above the ground. Two gallons per acre of Perenox at the rate of 50 lb. in 20 gal. of spray, were used. A small random gathering of leaves gave a percentage cover of 6.8 per cent for outer leaves and 3.1 per cent for inner. This was encouraging. However, in a series of further tests, only very poor under-leaf cover has been obtained in spite of trials with different aircraft and with various modifications.

At Closeburn Estate a Piper Super Cub was used at 80 m.p.h. and two gal. per acre of Perenox at 14 lb. per 100 gal. Only a very poor cover (0.28 per cent) of the outer leaves was found and on the inner leaves no copper could be detected.

At Murera Estate, a randomized block trial was carried out with the Piper Cub to compare the effect of employing flaps or not, and of 2 gal. *versus* 3 gal. per acre. Seven pounds of Perenox in 40 gal. were used. Single extra plots were also sprayed at higher concentrations, 14 lb. and 100 lb. per 40 gal., and also using the Anson aircraft with and without flaps. Again only very poor under-leaf cover was obtained, this being in the region of 0.2 per cent. The presence or absence of flaps and the 3 gal. *versus* 2 gal. per acre had no obvious effects.

In a final unreplicated test at Murera, Blitox at 5 lb. in 2 gal. was used (i.e. at the same level as with the first test described). The Anson was used with and without flaps and spraying 2 gal. and 3 gal. per acre and in addition the Piper Cub was employed with and without flaps at 3 gal. per acre and also at this rate, but with three runs over the same coffee. Slightly better cover was obtained than in the previous trial, this being in the case of the Anson, 0.6 per cent with flaps and 0.8 per cent without, but these are far from adequate. With the three runs at 3 gal. with the Piper Cub, only 0.4 per cent was obtained.

In a test at Chania Bridge Estate, Thika, using the Anson, delivering 4 gal. per acre of 1 lb. Blitox in 1 gal. of water, an estimated cover of 0.52 per cent for inner, and 0.31 per cent for outer, leaves of rather thin multiple-stem trees was found.

It would seem from these tests, that using present machines and methods, the amount of under-leaf cover which can be obtained is likely to be inadequate and the application of "tonic" sprays by this method cannot be expected to lead to successful results. The only possibility, if better under-leaf cover cannot be obtained, is if it can be shown that adequate anti-leaf-fall effect can be obtained by the upper surface cover obtained. This could only be decided by protracted and difficult tests.

(8) ATTEMPTS TO PRODUCE WEAK-SPOTTING

Further observation of the tree enclosed in a glasshouse showed that no weak-spotting developed on any of the leaves up to the end of 1955, except for those on a small group of branches at one point. These were directly under a drip from a small leak in the roof. Both leaf rust and weak-spots developed on these leaves. This confirms the opinion that weak-spotting is due to fungal infection.

Throughout a long series of inoculation experiments with rust, which are described later in this report, no suggestion that weak-spotting was developed in inoculated areas was found. The leaves of the tree had otherwise a normal proportion of weak-spots. There is thus no evidence that weak-spotting is a resistant reaction to rust invasion.

Further attempts to produce weak-spots on the glasshouse tree by means of inoculation with washings from trees in the field were carried out during the long rains of 1954. The sources of inoculation were trees at the Scott Laboratories and at Kimarauli Estate, Upper Kiambu. Washings were taken after spells of wet weather and from trees showing abundant weak-spottings. No weak-spotting developed on the inoculated foliage.

Leaf Rust—(*Hemileia vastatrix*)

GENERAL

General observations on the variations in amount of rust in the field have been made during 1954 and 1955 and on the relation of these to climate. The results of these observations will be embodied in an article dealing with the disease which should appear in the Coffee Board Bulletin for March, 1956. The effect of amount of inoculum in the field in the early part of the year and of the occurrence of infective weather associated with Grass Rains on the tendency to a build-up to epidemic proportions in July to August was clearly seen in these two years.

Interest among planters in obtaining control of the disease is increasing and studies of the epidemiology are becoming important as a means of determining the best times to apply protective sprays.

THE INCUBATION PERIOD

In order to determine the best time to apply sprays, it is essential to have a knowledge of the incubation period of the fungus, i.e. the time taken from germination of a spore until the fungal infection it produces develops its first crop of daughter spores.

Inoculation experiments were started in April, 1954, to determine the incubation period and whether it varied with time of year. They were continued until April, 1955. Six single-stem trees were chosen, three with low crop and three with high. On each, a single branch was selected and two young and two old leaves inoculated by placing a drop of water on the lower surface of the leaf, between the angle of the main vein and a lateral vein. A loopful of spores from a fresh rust spot was placed in the drop. Each leaf was inoculated in this manner at five points in all and on the same side of the mid-rib. The branch bearing the leaves was placed in an alkathene bag and sprayed with water. Spraying was repeated at intervals. The bag was removed after three days. The leaves were examined at intervals for rust spots in the inoculated positions. Graphs were drawn of the number of spots which had developed to a sporing condition at each inspection date as a percentage of the total eventually developing. Simple sigmoid curves were produced in the majority of cases and from these, the time taken for 5 per cent and 50 per cent of the spots to reach sporing could be estimated. The 5 per cent point, which may be taken as the date when sporing is just starting, varied from 3.0 to 6.5 weeks, averaging 4.6 weeks. The highest values were found during June and July. The 50 per cent point, which may be taken as the date by which strong spore production starts, ranged from 4.0 to 7.4 weeks and averaged 6.3 weeks, again being longest for the June to July period. The reason for this is in all probability the cold conditions which prevail in these months.

The incubation period is notably longer than has been observed in other countries where rust occurs, as low a period as ten days having been recorded in Ceylon. It is probable that this is connected with the somewhat low temperatures which prevail in general in Kenya coffee-growing areas and it seems likely that the effect is crucial in preventing much worse rust attacks in this area.

Based on a knowledge of the incubation period, a more detailed and precise spraying programme is to be published.

THE MARCH OF RUST ATTACK INTENSITY WITH TIME AT MAKUYU

In view of the fact that leaf rust control is very important in the lower and warmer East Rift areas of lower Thika, Makuyu, Mitubiri and Donyo Sabuk, it was thought desirable to determine the annual march of intensity of leaf rust attack, especially as there seemed to be some lack of certainty as to when the maximum occurred and in consequence when infection was likely to take place.

In consequence, during routine monthly visits, the Agricultural Officer collected random samples of 100 leaves from a group of trees on the experimental sub-station on North Kitito Estate, Makuyu. These were brought back to the laboratory and the number of leaves with rust spots, as well as the number of spots per leaf, were counted. The counts started in June, 1953, and were concluded in December, 1955. In each year there was a marked maximum centring around the month of August. In 1953, the outbreak was rather small, in 1954 very marked and 1955 rather small, but larger than in 1953. The 1954 outbreak lasted from June to October, with a peak in September. It would appear from these records, that the build-up of the disease to epidemic proportions follows the same general course as in the main East Rift area.

PHYSIOLOGIC RACES AND VARIETAL SUSCEPTIBILITY

A number of collections of rust have been made and sent to Dr. d'Oliveira, at Sacavem, Portugal. Dr. d'Oliveira is making a collection of coffee rusts from all over the world in order to study their physiologic forms and the susceptibility of coffee varieties to these. This work is in connexion with the United States Point 4 Mission on coffee rust. Of three collections from different localities in Kenya, for which results are so far available, each was found to be of a separate physiologic race. One of these was found attacking the selection K.7 in the Teita region. Inoculations with this race at the Research Station failed to take on K.7, but attacked SL.9 easily. K.7 in the Highlands has so far remained free of rust except for a few odd trees in the f.1 generation and rather more in the f.2 generation. It would seem possible that its resistance in the Teita region to the physiologic race present is less than in the Highlands.

K.7 often develops circular yellow areas up to 1 centimetre in diameter on its leaves. No spores are produced on these spots, though otherwise they are similar to rust infections. Examination of these was carried out by embedding in paraffin, sectioning and staining with the Margolena differential stain. No mycelium could be seen between the cells, but the latter were full of yellow granules, globules and aggregations, which stained as for fungal material. It would seem possible that the yellow spots represent a resistant reaction to attacks by *Hemileia vastatrix*.

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Coffee Berry Disease

GENERAL

In 1954, rainfall was higher than it had been since the first outbreak of the disease in Upper Kiambu in 1951 and the attack was heavier than it had been in the intervening year. A survey of the spread of the disease was made. It appeared that in Upper Kiambu, the more north-easterly estates were now more heavily attacked than had been the case earlier. Outside Upper Kiambu the disease was only present on a very few estates where pockets of highly susceptible types occur.

In 1955 the attack was of comparable intensity to that of 1954. A block of Harar coffee at the Scott Laboratories was attacked for the first time as well as certain other varieties. A heavy attack on what appeared without much doubt to be Harar, or a closely allied variety, was found on Aintree Estate, Ruaraka, at an altitude of 5,200 ft. This is the lowest altitude at which the disease has been recorded in the East Rift. Adjacent, French Mission coffee was unattacked. From

these and past observations in the Kiambu area, it would appear that inoculum is probably now present throughout the area, but that noticeable disease symptoms do not develop under the normal climatic conditions of this area unless highly susceptible coffee varieties are present.

CALCIUM SULPHAMATE TRIAL

In view of the report that this substance might have sub-systemic fungicidal properties and the probability that only with a material having such properties was it likely that a practical control of Coffee Berry Disease would be obtained, it was decided to carry out a trial to see whether it could control the disease.

Little was known as to its effects on coffee, so a wide range of concentrations. 0.1, 1 and 10 per cent were used. Single-tree plots, in a completely randomized layout with four replications were used. The trees were selected for having had a fairly heavy attack of the disease earlier in the year and a count was made of the number of diseased berries present on them. This data was used in a covariance analysis of the results. Spraying was carried out on Kentmere Estate, Upper Kiambu, at the beginning of the short rains, and only one application was given at a rate of three pints per tree.

The 10 per cent rate was found to cause severe scorching of both leaves and berries, followed by their abscission. Little damage was caused by the 1 per cent rate and there was a somewhat lower amount of disease developed on the trees than on those not sprayed. The difference was not statistically significant. The 0.1 per cent level produced no phytotoxic symptoms and the number of diseased berries was rather higher than with the control.

FUNGICIDE TRIAL I

This trial was designed to test a wide range of the newer organic fungicides which had not previously been tested against Coffee Berry Disease. In addition, very frequent applications of a copper fungicide, Perenox, were tried and a further test of calcium sulphamate was included. The trial was set up on Kentmere Estate, Upper Kiambu in the East Rift area and was commenced a short while before the onset of the long rains in 1955.

Fifteen treatments were compared using six replications of a balanced, incomplete block design with three plots per block. Each block consisted of one head on each of three multiple-stem trees, selected for having three equal heads each. In this way, individual tree variations in susceptibility and yield could be statistically controlled. The following fungicides were applied at monthly intervals during the long rains (March to May) and the short rains (November to December), giving a total of five applications: Perenox, Karathane, Verdasan, Fermate, Zerlate, Dithane, Actidione, Captan, Glyoxalidine and calcium sulphamate. The latter material was tried at 1, 3 and 6 per cent. In addition, Perenox was applied at 14-day intervals throughout the season, one treatment starting with two applications before the long rains commenced and the other commencing with the onset of these rains.

Only Perenox applied at fortnightly intervals and Verdasan gave an effective control of the disease. No control could be detected when Perenox was applied at the same frequency as Verdasan. As fortnightly fungicidal application is completely impracticable, Verdasan affords the best possibility of control as yet. In view of the earlier inability to obtain direct control of the disease with fungicides, the importance of these results is considerable.

Repeated calcium sulphamate treatments at 1, 3, and 6 per cent were all found to be highly phytotoxic although previously a single application of 1 per cent had not produced any adverse effects.

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FUNGICIDE TRIALS II/1 AND II/2

These trials were laid down at the onset of the 1955 short rains. The first of these was of similar design to Trial I and its main feature was the inclusion of two new experimental stickers in combination with Verdasan and Perenox, as well as the inclusion of another organo-mercurial. In Trial II/2 a different design had to be used owing to the inclusion of grisofulvin of reputed systemic properties. This substance was tested at a range of concentrations.

FUNGICIDE TRIAL III

This was laid down in the short rains, 1955, at Yara and Kentmere Estates, with three replicates at each locality. It is a yield trial to assess the value of the main fungicide treatments which have already given encouraging results. Estimates of Brown Blight and Berry Disease were made on samples. Preliminary results indicate a strong control of Brown Blight by Verdasan.

LABORATORY INVESTIGATIONS

These were carried out by Mr. K. R. Bock during the period May to October, 1955, and the following is a summary of the main lines of work undertaken based on a mimeographed progress report he has prepared.

(a) *Standardization of Inoculum*.—In view of the difficulties of obtaining adequate germination or infection using spores produced in culture, a technique was evolved in which detached berries were inoculated with the fungus and the resulting spore masses used as inoculum.

(b) *Studies on Infection Using Detached Berries*.—Detached berries were found to be a useful means of studying a number of aspects of the host-pathogen relationship. The technique has limitations as the balance between host and pathogen must be affected in some way by detaching the berry. In spite of this it has proved invaluable in preliminary researches:—

- (i) The mechanism and duration of infection. Surface scalps were taken from inoculated berries and examined under the microscope. Germination percentage was found to be high under these conditions. The germ tube forms an appressorium and infection is presumably by a peg. Penetration may be complete in less than five hours.
- (ii) The effect of dessication of conidia on infection. Detached berries were inoculated by placing spores in a drop of water on the berry and then dried by blowing a current of air across them with a fan. After a period water droplets were placed on the point of inoculation and the berries placed in a damp atmosphere. Dessication for up to six hours led to a rapid decrease in the number of berries developing disease symptoms, but there was still a considerable degree of infection after 24 hours' desiccation.
- (iii) Numerical threshold of infection. There were indications that there is an optimum spore density for inoculum and that this lies above 10^4 spores per cubic centimetre.
- (iv) Incubation periods. The average incubation period appears to be in the region of 7–14 days. With young berries 1–5 mm. in diameter, it may be as short as 72–84 hours.
- (v) Effects of temperature on rate of lesion development. In the absence of apparatus for a critical study of the effects of temperature and humidity, only those due to large differences could be studied. Constantly low temperatures depress the rate, while fluctuating temperatures show an initial retarding effect. Berries from a tree grown under high humidity and temperatures in a glasshouse showed a more rapid rate of lesion development than a clone of the same tree grown outside.

- (vi) Differential reaction of host varieties. The effect of variety on the production of lesions after inoculation of detached berries showed that a higher percentage of lesions developed on susceptible varieties and also that the type of lesion which develops is affected. Thus, certain varieties show a preponderance of the "scab" type of lesion. An examination of these led to the conclusion that they are a type of non-susceptible reaction. Growth of the fungus is limited to the superficial tissues and spore production is very limited. Scab lesions apparently never develop into active lesions.
- (vii) Effect of fungicides on the pathogen. Fungicides were sprayed on to detached berries until there was complete saturation of the surface. They were then allowed to dry and a drop of inoculum pipetted on to the berry surface. Many of the fungicides tested did not produce any reduction in the percentage of diseased berries resulting as compared to control and in some there appeared to be increases. The results of these tests were very similar to those obtained with the same fungicides in the field. Thus Verdasan showed strong control of the disease in both cases whereas Karathane showed no control. The method thus shows great promise as a standard preliminary test for the effectiveness of fungicides against the pathogen. Grisiofulvin showed exceptional promise in these tests. e?

(c) *Studies of Infection in the Field.*—Using the improved techniques of inoculation, it was found possible to infect berries under environmental conditions where "non-susceptibility" to attack is normally shown by all varieties other than the most susceptible. However, as the inoculated berries are enclosed in plastic covers to maintain humidity, this may have had some effect.

Maleic Hydrazide Trial

As maleic hydrazide now appears not to be likely to have carcinogenic properties, it was decided to see if growth control by this substance could encourage flowering and increase of yield in localities where coffee is shy-bearing. Cherangani, near Kitale, is a noteworthy case of an area where coffee is shy-bearing, so a trial was set up on Riverglade Estate in this area in 1954. Two concentrations of maleic hydrazide were applied, 0.2 per cent and 0.6 per cent at three times: July, August and September. The aim was to reduce the amount of growth for varying lengths of time during the second half of the growing period. A control treatment was also included. This gave seven treatments in all and these were arranged in four blocks in a randomized block design. Plots were single rows of 12 trees. Crop, both as cherry and clean coffee, is being recorded and observations made on flowering, growth rate and general effects on the trees. So far, only the 1954/55 crop has been recorded and no significant effects on yield were detected.

Observations on growth have shown that this was very slow and very even throughout the period August, 1954, to January, 1955, but that there was a small peak at the onset of the rains in February. Growth records for later in 1955 have not yet been received. All treatments with maleic hydrazide appear to have depressed growth, the most effective being 0.6 per cent in July, closely followed by 0.6 per cent in September. The other treatments had a considerably less effect than these. An examination of the trees in May, 1955, showed very severe effects on growth of the two treatments mentioned above, especially with the September spray. Very little new growth had been formed on the trees for some time past and in consequence the trees were very low in leaf, those present being very dark green, stiff and old in appearance. New growth was just commencing and consisted of very numerous, short axillary shoots with small, narrow, elongate leaves.

Inflorescence buds were abundant, but were elongated and had a "vegetative" appearance. It would appear that the 0.6 per cent concentrate was too strong, and will produce adverse effects on yield.

Flowering was scored for intensity during 1955, but no obvious effects of treatment were detected.

Growth Recording

Growth has continued to be recorded at the Scott Laboratories and at the Coffee Research Station during 1954 and 1955. In both places recording was commenced on the multiple-stem plots in 1954. At the Coffee Research Station, the artificial shade treatment was applied in July, 1955. This produced a rapid change in the aspect of the trees, the foliage becoming darker green and more lush in appearance. The irrigation treatment was commenced at the end of February, but only one application was applied to one block as insufficient pressure was available. A booster pump is to be installed.

At the Coffee Research Station, there was a marked growth peak in April/May, 1954, and some growth during July/August, the result of rain at this time. Growth was at a minimum in October/November. There was a small peak in November/December. Multiple-stem coffee showed a somewhat higher growth rate than single-stem throughout the first half of the year, but markedly less during the short rains growth period. In both cases, stripped trees showed greater growth, but followed the same general pattern.

Soil nitrogen determinations were carried out by the Soil Chemist in the growth recording plots during 1954 and it was found that whereas there was adequate soil moisture available following the marked growth peak of the long rains, nitrates fell off very markedly at the time growth was decreasing rapidly. There appears to be strong circumstantial evidence that this rapid decrease of growth after the first flush is connected with limiting supplies of soil nitrogen.

In 1955, growth started early due to the February rain, but the peak was much lower than in the previous year and gradually decreased to a minimum in September. There was a small peak in the short rains. As before, stripping increased the growth rate, but the pattern remained the same. There was little difference between multiple-stem and single-stem in the long rains, but the latter grew more rapidly during the short rains.

The irrigation treatment led to a small extra growth rate during the long rains. Shading led to extra growth towards the end of the short rains peak.

At the Scott Laboratories, the 1954 long rains peak was less marked than at Ruiru and the short rains growth was much more prolonged. There was little difference between any treatments during the long rains, nor between single-stem and multiple-stem throughout the year. During the short rains the stripped trees grew much more rapidly. In 1955 the growth picture was very similar to 1954, but the rains growth started earlier due to the February rain. There were no marked minima.

Elgon Die-Back

Elgon Die-Back was observed in Upper Kiambu in June, 1954, and at Solai in July. In both cases, only a mild attack occurred. Comparison with typical symptoms on Elgon confirmed the diagnosis. In both cases, isolations were made from the proximal region of lesions at an early stage of development. A preponderance of isolations consisted of a *Glomerella* sp., probably *G. cingulata*.

Serial sections of young lesions showed the tissues to be full of fungal mycelium. From examinations of the progress of the disease, it would appear that the first symptom is invariably a lesion causing the death of one or two internodes in the green bark portion of a branch, usually some way back from the apex. The distal part of the branch then wilts and dies. On reading the literature, it would seem that the importance of this primary lesion does not appear to have been recognized. Further, if tests of starch content are made at this early stage, branches may be found with developing lesions, but with very adequate starch deposits. There is thus evidence that the disease cannot be due to starch deficiency as has been suggested. It would appear to the writer that in view of the observations just outlined, the possibility that the disease is due to fungal attack should be re-examined.

Miscellaneous Investigations

Flower-bud abortion was reported at Nyeri and on examination showed that the buds were attacked by *Botrytis cinera*. The fungus was isolated and inoculations were carried out, but without success either with inflorescence buds on the plant, or detached inflorescences in petri-dishes. The disease might conceivably be due to competition with vegetative growth as conditions had been very conducive to the latter. However, starch seemed to be present to an adequate extent in affected branches. The cause of the disease thus remains uncertain.

Root rot has been observed several times in the past two years. It would appear to be largely connected with shade removal. Ring-barking of shade trees so as to exhaust their root systems of reserves is usually incorrectly done if at all. The aim should not be to kill the tree quickly but to keep it alive in a ringed condition for at least a year.

Cases of intermittent chlorosis were common in the cold weather in both 1954 and 1955. A pair of leaves on an otherwise healthy branch became, in extreme cases, completely devoid of green coloration. The cause is obscure, but the cases investigated always show the disease to be developed in depressions and places to which cold air may drain. The trees are also usually growing fairly rapidly at the time. It is suggested that short exposure to cold at night, when growth is occurring, may upset the chloroplast division in the meristems of the leaf primordia, so that chloroplasts are absent from some of the daughter cells.

Seedling disease due to *Rhizoctonia solani* was seen for the first time for many years in a nursery at Donyo Sabuk. Cheshunt mixture and potassium permanganate solution applications have apparently not controlled the disease, which has caused considerable damage. Perenox and Verdasan applications have been suggested.

A tip burn and scorching of young leaves was widespread in Upper Kiambu in June, 1954. A fungus, which appears to be a *Cytospora*, was almost invariably isolated in culture and was also present on the dead tissue. It would seem probable that this is the cause of the disease. The damage caused was not of great importance.

Cases of lightning damage were reported at frequent intervals. In one case in Upper Kiambu, the rare occurrence of trees dying around a shade tree that had been struck was reported. As in the single previous case reported in an earlier Annual Report (1948), only coffee bushes immediately adjacent to the shade trees were affected, the root system having been killed.

Suberization and splitting of green berries was common in 1955. It affected berries produced by a short rains flowering the previous year, and which were subjected to drying winds in the early part of 1955. The berries were covered with a light brown, rough, corky deposit, and in extreme cases, splitting of the berry occurred.

A case of death of embryo was reported by the Coffee Board's liquorer as producing "stinkers". The beans were perfectly formed and normal-sized embryos were present, but these were dead, blackish-brown and shrivelled. A small pit had developed at the end of the bean opposite the embryo radicle. A visit to the estate which had produced them, gave little suggestion as to the cause of the death, which must have occurred only shortly before picking. Some very yellow trees with very heavy crop were present, however, and it is possible the "stinkers" came from these. Only the early crop was affected.

In 1954, star-flowering was very widespread at the beginning of the long rains. It appeared to be due to the flowering showers being followed by wet, dull and cold weather which interfered with the normal development and opening of the flowers, so that greenish, short thick corollas developed. This effect on flowering of cold, wet, weather has been observed before. The malady was reported from Ruiru, Kiambu, Nyeri and Mount Elgon.

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REPORT OF THE AGRICULTURAL CHEMIST (COFFEE SERVICES), 1955

During the year there has been no improvement in the laboratory staff position but the reorganization of laboratory equipment and layout for the investigation programme into soil nitrogen and the nitrogen nutrition of coffee has proceeded satisfactorily. An extension was completed at one end of the original laboratory building in which accommodation is provided for a balance room and a sample preparation and storage room.

Soil Nitrogen and Related Studies

The mineralization of natural soil nitrogen under a mature coffee crop (Kikuyu red loam coffee soil) was studied in terms of soil $\text{NO}_3\text{-N}$ and $\text{NH}_3\text{-N}$ over a period of 14 months. Details of sampling technique, depth and experimental layout have been given in this section of the Annual Report, 1954, Part II, page 115, and are not repeated here. The sampling covered the period March, 1954, to May, 1955.

Statistical analysis of the large number of figures available was impracticable and it was decided that, as the main interest was with general trends in reference to coffee growth (records of which were kept during the experiments), single complete sets of data would be selected at random for each month over the full period and would then be analysed in detail. At the same time, the figures obtained at each individual sampling interval were calculated as a single-weighted mean value over the sample depths, i.e. weighted mean for five sample depths at each sampling time. In this way it has been possible to estimate statistically the important trends and differences in the data.

The main results are summarized briefly on page 102 since a full and detailed consideration of this work will be published in the future.

The mean values for the pruning system figures in the above table include replication, sample depth and sampling times; for the soil sample depth they include replication and pruning system and the sampling times; for successive sampling times they include sampling depth, pruning system and replication.

The mean level of soil nitrate nitrogen under the multiple stem pruning system is very significantly greater than under the single stem pruning system. A similar but non-significant difference is apparent for soil ammonia nitrogen. It would seem in the first instance that soil moisture is not a contributing factor to this difference, which could be the effect of a combination of conditions such as the degree of self shading of the soil, root system differences in relation to the point of sampling, interception of rainfall by the foliage of the tree, etc., but a consideration of the soil moisture interaction means for pruning versus sample depth shows that overall there was a very significantly lower level of soil moisture in the 0-3 in. sample under coffee pruned on the multiple-stem system. The conclusion is that some general difference does occur under field conditions.

The figures for soil sample depths show a very large general difference between the 0-3 in. and 3-6 in. samples, of nitrate and ammonia nitrogen and of soil moisture. But below the 6-in. level variations are relatively slight. A detailed consideration of the interaction of soil sample depth with sampling intervals, and in conjunction with soil moisture and gypsum block records, provides some evidence that suggests both upward and downward movement of nitrate nitrogen. Downward movement of nitrate nitrogen was related quite

Table I.—Main Experimental Effects

(a) Overall differences under two systems of pruning (means of 140)

	Single Stem System			Multiple Stem System			L.S.Ds.
	NO ₃ -N (ppm oven dry soil)	NH ₃ -N (ppm oven dry soil)	Soil Moisture per cent	NO ₃ -N (ppm oven dry soil)	NH ₃ -N (ppm oven dry soil)	Soil Moisture per cent	
	..	..	..	4.65	6.30	1.40**	
	..	..	..	3.02	3.27	N.S.	
	..	..	..	30.8	30.6	N.S.	

(b) Soil Sample Depth (means of 56)

	0-3 in.	3-6 in.	6-12 in.	12-18 in.	18-24 in.	L.S.Ds.
NO ₃ -N ..	10.24	5.45	4.48	3.69	3.53	1.15*
NH ₃ -N ..	4.28	3.21	2.63	2.66	2.94	0.52*
Soil Moisture ..	26.4	30.2	32.3	32.5	32.2	0.4*
						0.6**

(c) Successive Sampling Times (means of 20)

Sampling times	1 (Mar., 1954)	2	3	4	5	6	7	8	9	10	11 (Jan., 1955)	12	13	14	L.S.Ds.
NO ₃ -N ..	8.22	6.42	2.29	2.77	4.90	4.99	8.32	7.32	8.51	2.83	3.25	8.21	5.62	3.04	1.78*
NH ₃ -N ..	2.21	3.25	3.06	2.85	3.54	2.84	2.97	6.70	5.34	2.65	2.10	3.14	1.30	1.85	0.77*
Soil Moisture ..	21.9	37.9	37.3	41.2	29.1	32.8	26.3	24.9	24.8	30.0	24.1	32.0	28.0	40.0	0.7*
															2.36**
															1.02**
															0.9**

NOTE.—Successive sampling times represent monthly intervals, excluding April, 1955.

clearly to the onset of main rainfall periods with consequent movement of moisture from the topsoil downwards. With the knowledge (derived from laboratory incubation experiments described later) that nitrate nitrogen production in the topsoil of the Kikuyu red loam coffee soil decreases with lowered moisture content, and that the formation of significant quantities relative to time ceases at just below wilting point soil moisture (i.e. 5/6 W.P. moisture content), it is difficult to account for the large quantities of nitrate nitrogen that are found in the 0-3 in. topsoil layer when the soil is drying out except on the assumption that a substantial upward movement takes place from below. Figures which suggest this trend (data for 0-3 in. soil depth only) are shown in Table II.

If the soil moisture figures are taken as an approximate indication of the main rains periods, i.e. long rains, 1954, 2-4 inclusive; short rains, 1954, 9 and 10; long rains, 1955, 13 and 14, it will be noted that high nitrate nitrogen and low soil moisture figures go together. Active and substantial coffee tree growth, and presumably uptake of nitrate nitrogen, took place over the sampling times 2 and 3, 5, 10 and 13 and 14, and some of the low figures recorded might be a result of uptake by the coffee although little, if any, coffee feeding roots were found in the top 3 in. of the soil, which was unmulched. This is quite usual, and in general it is inferred that nitrate formed in the top 3 in. of unmulched soil is first washed down the profile where the coffee feeding roots are present before the major portion can be taken up. Accumulations in this top 3-in layer may, therefore, be attributable to: (a) formation without sufficient rainfall to leach the nitrate downwards; and (b) when a build-up occurs at a time when the moisture content is below the wilting point level, to an upward movement with soil moisture from below the 3-in. depth. This aspect of the problem is now receiving more particular attention.

Ammonia nitrogen figures are included in Table II because they show the accumulation of this nitrogen form which takes place at low soil moisture values, e.g. sampling times 8 and 9. This has been studied in the laboratory under controlled conditions of incubation and the results are recorded later in this report.

Figures in Table I, section (c), show that in the top 2 ft. of this coffee soil profile nitrate nitrogen accumulates at dry times of the year between the long and short rains, i.e. sampling times 5-9 with small fluctuations apparent, and between the short and the long rains, i.e. sampling times 11-13. Ammonia nitrogen is relatively stable, but shows high accumulations in the two driest months of the period of the experiment, i.e. sampling times 8-9, when the soil moisture level was at or below wilting point.

VERTICAL DISTRIBUTION OF NITRATE NITROGEN IN KIKUYU RED LOAM COFFEE SOIL

In January, 1955 (dry season), soil samples were taken at intervals to a depth of 9 ft. under multiple and single stem pruned coffee by the Plant Pathologist, in connexion with proposed irrigation studies. The opportunity was therefore taken of examining soil samples for the vertical distribution of nitrate nitrogen in the profile.

The sampling was carried out in two plots of an experiment for each pruning system, i.e. four randomized field plots were sampled at 6 in., 3 ft. 6 in. and the centre point, along the diagonal distance between two trees. The coffee spacing is 10 ft. $\times$ 10 ft. square. Unfortunately, one set of 6-in. samples taken under multiple stem coffee was not analysed and therefore statistical analysis has been confined to a comparison of results at two horizontal distances on the diagonal only, under the multiple stem coffee, i.e. 3 ft. 6 in. and 7 ft. from the tree trunk. The soil moisture content was less than the wilting point value in the top 6-9 in. of soil at the time of sampling. The results are summarized in Table III.

Table III.— NO_3-N . (ppm oven dry soil)

Sample Depth		Multiple Stem (Means of 4)†	Per cent of Total	Single Stem (Means of 6)‡	Per cent of Total
Surface—	..	35.9	19.8	25.3	17.9
1 in.	..	12.7		9.4	
3 in.	..	6.7		6.3	
6 in.	..	4.7		3.8	
9 in.	..	2.9	23.5	2.1	21.1
1 ft.	..	1.8		1.7	
2 ft.	..	2.3		2.1	
3 ft.	..	11.4		4.5	
4 ft.	..	24.5		12.7	
5 ft.	..	24.2		16.1	
6 ft.	..	22.3	56.7	17.6	61.0
7 ft.	..	17.2		18.6	
8 ft.	..	41.5		21.5	
9 ft.	..	19.2*		7.8*	
L.S.Ds.	..				10.5**

NOTES—

*Two replications at the 3 ft. 6 in. and centre distance along the diagonal between two trees.

†Two replications of the 6 in., 3 ft. 6 in. and centre distances along the diagonal between two trees.

Percentage figures have been inserted for bracketed depths indicating the dispersion of nitrate nitrogen within the profile.

Under the multiple stem pruned trees the results do not show significant differences in nitrate nitrogen between the samples taken at the 3 ft. 6 in. and centre distances from the base of the tree, nor was the interaction of horizontal distance versus sample depth significant. Under the trees pruned on the single stem system the mean values for all depths at each distance along the diagonal showed significant differences and the interaction with soil sample depth was also significant. (See Table IV.)

Table IV.— $\text{NO}_3\text{-N}$ (ppm oven dry soil). Means of 2. Single Stem Pruned Coffee

Sample Depth				6 in.	3 ft. 6 in.	Centre
Surface—						
1 in.	..	..	..	43.2	19.4	13.3
3 in.	..	..	..	3.6	9.8	14.8
6 in.	..	..	..	2.3	8.2	8.5
9 in.	..	..	..	2.2	2.1	7.4
1 ft.	..	..	..	1.1	2.5	2.7
2 ft.	..	..	..	3.2	0.7	1.3
3 ft.	..	..	..	2.7	1.3	2.5
4 ft.	..	..	..	1.6	4.3	7.8
5 ft.	..	..	..	4.2	17.8	16.1
6 ft.	..	..	..	8.5	14.7	25.3
7 ft.	..	..	..	10.2	15.5	27.3
8 ft.	..	..	..	12.1	18.2	25.7
9 ft.	..	..	..	14.2	21.6	28.7
GENERAL MEAN—						
(Means of 26)	..	..	..	8.4	10.4	13.9

L.S.Ds. Means of 26 = 3.7*; 5.0**

L.S.D. (Interaction) Means of 2 = 13.5*

The mean soil nitrate nitrogen content increases with increasing horizontal distance from the tree base in the 9-ft. profile. Soil nitrate nitrogen is very high in the surface 1-in. samples and is at a minimum in the region of 1–2 ft. down the profile. In general, gradual increases take place with increased depth below this zone. In relation to the low moisture values determined for the upper 9 in., the order of magnitude of nitrate nitrogen values in the 1–2-ft. depth may represent the effect of moisture movement upwards during the intensely dry weather which occurred prior to the sampling date. The degree of nitrate nitrogen accumulation increases with increased distance from the base of the tree at depths below 5 ft., and is, in fact, highest where the least volume of tree roots are to be found.

INFLUENCE OF WEED GROWTH ON NITROGEN IN THE SOIL AND COFFEE LEAF

During the long rains period, 1955, i.e. April, May, early June, four sets of soil samples were taken at close vertical intervals under single stem coffee with and without the normal weed growth. The plots were sited in the same field trial area as that from which samples for the study of nitrogen mineralization were taken. (See previously recorded results.) A summary of results is presented in Table V.

Table V.— $\text{NO}_3\text{-N}$ and $\text{NH}_3\text{-N}$ (ppm oven dry soil). Means of 8

Sample Depth	WEEDS PRESENT		WEEDS ABSENT	
	$\text{NO}_3\text{-N}$	$\text{NH}_3\text{-N}$	$\text{NO}_3\text{-N}$	$\text{NH}_3\text{-N}$
0-1 in. 	4.6	3.41	6.9	3.26
1-2 in. 	4.4	3.48	5.1	2.96
2-3 in. 	3.5	2.95	4.9	2.84
3-4 in. 	2.7	2.79	4.0	2.54
4-8 in. 	2.6	2.27	2.3	2.48
8-12 in.	1.7	2.33	2.1	2.89

NOTE.—Figures are means of data from four sampling times.

The mean difference with depth are significantly different for nitrate nitrogen but not for ammonia nitrogen. Overall differences between comparisons of $\pm$ weed growth were not significant in this experiment, but there was a greater concentration of nitrate nitrogen in the first foot of soil where weed growth was absent. Weed growth, under the conditions of the experiment, was at no time rank for control by slashing was carried out as it is under normal good management conditions. Since the majority of weed roots are found in the top 3 in. of the soil, whereas the feeding roots of unmulched coffee are found at 3-4 in. and below, it is of interest to compare the relationship of nitrate and ammonia nitrogen in the top 3 in. of the soil when expressed as a percentage of the total concentration in the 1-ft. depth of soil, $\pm$ the presence of weed growth. Soil nitrate nitrogen figures are 67 per cent and 64 per cent and ammonia nitrogen figures are 53 per cent and 57 per cent respectively for no weed growth and weed growth. This suggests that differences due to the presence or not of weeds, are quantitative only and that there is little or no influence on distribution in the topsoil.

Table VI.—Total Nitrogen content of Coffee Leaf Samples
(M eq. N/100 gms. dry tissue)

Replication	Unrestricted Weed growth	Clean Chemical Weed control (P.C.P.+2, 4-D herbicides)
B 1 	134.71	160.62
B 2 	128.71	162.97
B 3 	136.84	149.91
Mean 	133.53	157.83

The results in Table VI were found for coffee leaf samples collected towards the end of the long rains, May, 1955, from the unweeded and chemically weeded plots of the formal herbicide trial. There is a consistently higher leaf nitrogen content in the absence of weed growth which suggests active competition between weeds and coffee, for the naturally available soil nitrogen supply.

LABORATORY INCUBATION STUDIES ON THE KIKUYU RED LOAM SOIL

In parallel with the studies of natural soil nitrogen mineralization in the field reported earlier, a study of the relationship between soil moisture and the mineralization of soil nitrogen was undertaken. Results have proved to be of considerable interest and have aided in the interpretation of results obtained on the field soil samples.

A detailed report of the results will not be made here as a separate report is being written for publication elsewhere. Summarizing, it was found that in the Kikuyu red loam topsoil the nitrate nitrogen formation rate, and the final total quantity measured after an incubation period of 32 days, was greatest the higher the maintained soil moisture value was between the wilting point and field capacity values, i.e. 21 per cent to 42 per cent moisture content on an oven dry basis. Production of nitrate nitrogen took place, and accumulated, at the wilting point moisture content, but no appreciable or significant formation occurred at 5/6, 4/6 or 3/6 of the wilting point soil moisture value, or at air dry soil moisture content. The difference between the wilting point and the 5/6 wilting point moisture content figure of the topsoil was only 3.5 per cent, and yet the influence on the nitrate nitrogen production was very large indeed under the controlled experimental conditions (e.g. at the end of a 32-day incubation period the soil held at wilting point might contain 29.2 ppm $\text{NO}_3 - \text{N}$ on an oven dry soil basis, whereas the soil at 5/6 wilting point moisture content might contain 9.5 ppm $\text{NO}_3 - \text{N}$. Both soils started with a content of 8.2 ppm $\text{NO}_3 - \text{N}$).

The ammonia nitrogen content of the soil showed reverse trends. When nitrate nitrogen was produced, and accumulated, the ammonia nitrogen content of the samples fell to low and generally stable values. When no nitrate nitrogen was formed, ammonia nitrogen accumulated in the soil in considerable quantities. From 5/6 the wilting point soil moisture content, downwards, ammonia nitrogen accumulation occurred over the 32-day incubation period and the rate of accumulation decreased with decrease of soil moisture content down to the air dry soil moisture level.

Subsequently, substantial ammonia nitrogen figures were found for field soil samples taken during the driest months of the year, when the soil moisture value in the field samples was less than the wilting point figure. Conversely, soil nitrate content in the field continued to increase steadily under similar moisture conditions and it has been suggested in this report previously that this is probably the result of an upward movement of soil moisture carrying with it some nitrate nitrogen.

KJELDAHL NITROGEN DETERMINATIONS OF COFFEE LEAF MATERIAL

Investigation of the methods of Kjeldahl nitrogen digestion applicable to leaf material were carried out to find the method which combined most reasonably, accuracy, reproducibility of results and speed of manipulation and digestion. The method selected finally was a semi-micro procedure using concentrated sulphuric acid with potassium permanganate (after Beet, A. E., *J. Appl. Chem.*, 1953, 25, 968, and *Nature*, 1955, 175, 573). A detailed report of this work has been completed and will be published in a future number of *The Analyst*.

Napier Grass Studies

Little further work has been undertaken since the previous report. On page 127 of the Annual Report, Vol. II, 1954, results were recorded for the effect of potassium fertilizer on dry matter yields and plant nutrient content of the Napier grass harvested from a $2^3\text{N} \times \text{P} \times \text{cattle manure}$ trial with plots split for the potassium fertilizer. In May, 1954, leaf samples were taken (mid 6-in. length of the first fully open leaf) from the split plots with and without the addition of 1 cwt. muriate of potash per acre, and these have been analysed for their potassium content. The object was to obtain information on the uptake of the potassium.

Table VII.—K% Dry Matter*

Main Treatments	BLOCK III		BLOCK IV	
	+K	—K	+K	—K
(I)	4.40	4.51	4.41	4.47
N	4.32	4.78	4.25	4.71
P	4.00	4.60	4.59	4.72
NP	4.47	5.05	4.47	4.58
NC	4.94	5.25	4.93	5.04
PC	4.52	4.59	4.72	4.78
NPC	5.12	4.79	4.85	4.94
Mean	4.55	4.82	4.59	4.79
Mean + K.. .. .	4.57			
Mean — K.. .. .	4.81	Mean diff. =	0.24***	

NOTES—

N=1 cwt./acre ammonium sulphate;

P=1 cwt./acre soda phosphate;

C=16 tons/acre cattle manure.

*Flame photometer analyses were made by Mr. R. Kempton, Agric. Chemist, Scott Agricultural Laboratories, Nairobi.

The mean leaf potassium content was lower in the presence of potassium fertilizer, and the mean difference was highly significant. This is not an expected result, and it might be interpreted that increased potassium uptake did not take place in the presence of the fertilizer. However, it was shown in the results reported in 1954 that a substantial dry matter yield increase did result from the use of potassium fertilizer and that over all the treatments there had been a quantitative increase in potassium taken up, i.e. +42.6 lb. per acre in the presence of the potassium fertilizer.

A COMPARISON BETWEEN DIFFERENT TYPES OF PHOSPHATIC FERTILIZERS APPLIED TO ESTABLISHED NAPIER GRASS GROWING ON A SHALLOW KIKUYU RED LOAM SOIL

A series of simple trials were laid down on various crops during 1955 to compare the performance of three different types of phosphatic fertilizer. The results with Napier grass are recorded here, other crop results are given later in this report.

The experimental treatments were commenced with the long rains, 1955. Previous history of the area was coffee until just before the long rains, 1953, silage maize in the long rains, 1953, and the Napier grass was planted for the short rains, 1953. No fertilizers or manure had been applied to the experimental area since before 1947 within certain knowledge.

The trial is in the form of a simple randomized block layout with eight treatments and three replications. The nitrogen fertilizer treatment was applied at the beginning of both the long and the short rains, but the phosphorus fertilizers were only applied to the long rains crop, i.e. residual effects only on short rains crop. Details of fertilizer treatments and rates, and of crop yields are given in Table VIII. Nitrogen fertilizer was placed in a band on one side of the stool row, phosphorus fertilizer was concentrated in a band along the opposite side of the stool row; the side of application of the nitrogen fertilizer was reversed from the long to the short rains.

Table VIII.—Napier Grass Yields (Tons/acre)

Treatments	DRY MATTER		GREEN MATTER	
	L.R. Crop	S.R. Crop	L.R. Crop	S.R. Crop
(1)	4.53	1.79	24.01	10.77
N (1 cwt/acre ammonia sulphate) ..	4.74	1.95	25.13	11.73
Ps. (100 lb./acre double super-phosphate)	4.66	2.01	24.70	12.13
P.b.s. (292 lb./acre basic slag) ..	4.65	2.13	24.66	12.84
P.h.r. (145 lb./acre hyperphosphate reno)	4.52	1.71	23.97	10.29
N.Ps.	4.70	2.19	24.92	13.19
N.P.b.s.	4.78	1.93	25.34	12.29
N.P.h.r.	4.66	2.04	24.70	11.60

NOTES:—L.R.=Long rains crop, harvested on 7th July, 1955;

S.R.=Short rains crop, harvested on 28th February, 1956.

The quantities of phosphorus fertilizers applied on a per acre basis were obtained by equating the citric soluble P_2O_5 content of hyperphosphate reno and basic slag materials with the content of 42 lb. water soluble P_2O_5 in the double superphosphate fertilizer. The rate of application was 42 lb. P_2O_5 per acre.

No statistically significant treatment effects were recorded for either crop but an inspection of the two-way tables suggests that while there has been little or no response to ammonium sulphate, a possible response has occurred with double superphosphate and basic slag, particularly to the short rains' residual treatments.

Table IX.—Napier Grass Yields. (Tons green matter/acre)
Nitrogen x Phosphorous two-way tables

	(1)	Ps.	P.h.r.	P.b.s.	Means of 12
LONG RAINS—					
(1)	24.01	24.70	23.97	24.66	24.33
N	25.13	24.92	24.70	25.34	25.02
Means of 6 ..	24.57	24.81	24.33	25.00	—
SHORT RAINS—					
(1)	10.77	12.13	10.29	12.84	11.50
N	11.73	13.19	11.60	12.29	12.20
	11.25	12.66	10.94	12.56	—

This trial is continuing.

PRODUCTION OF NAPIER GRASS ON VLEI SOILS

The camber bed cultivation system for vleis which is under trial at this station, was described in detail in a recent publication (*East African Agricultural Journal*, 1955, 21, 69, reprinted in *Coffee Board Kenya Bulletin*, 1956, 21, 9), and the yield records for maize and beans were also reported in *Ann. Rept. Dept. Agric. Kenya*, 1954, pt. II, p. 137. The trial was planted to Napier grass at the beginning of the long rains, 1955, and yield data are presented here for the

long and short rains crops. Napier grass was planted on 24th March, 1955, and to ensure an even stand with equal numbers of plants per plot, three-eye setts were used instead of continuous overlapping canes as recommended for normal planting practice. Cattle manure was broadcast, double superphosphate was placed in the planting position below the setts and ammonium sulphate was broadcast after the plants were well established. Details of treatments, and yield results are presented in Tables X and XI.

Table X.—*Napier Grass Yields (Tons Dry Matter/acre). Long Rains, 1955*
(Post-establishment cut)

Treatment	Yield (Means of 3)		Yield Effects (Means of 12)	
(1)	0.36	(1.91)	—	—
N. (2 cwt./acre ammonium sulphate)	0.55	(2.92)	—	—
P. (1 cwt./acre double superphosphate)	1.63	(8.64)	+1.33	(+7.05)
C. (10 tons/acre cattle manure) ..	1.46	(7.74)	+0.94	(+4.98)
NP.	1.83	(9.70)	—	—
NC.	1.24	(6.57)	—	—
PC.	2.65	(14.05)	—	—
NPC.	2.78	(14.74)	—	—
L.S.Ds.	0.41*;	0.56**	0.39***	—

NOTE.—Figures in brackets are yields of green material per acre.

Table XI.—*Napier Grass Yields (Tons Dry Matter/acre). Short Rains, 1955*

Treatment	Yield (Means of 3)		Yield Effects (Means of 12)	
(1)	1.66	(7.78)	—	—
N. (2 cwt./acre ammonium sulphate)	2.05	(9.58)	+0.58	(+2.72)
P. (Residual, long rains)	2.38	(11.11)	+0.96	(+4.47)
C. (Residual, long rains)	2.91	(13.60)	+1.03	(+4.80)
NP.	3.60	(16.81)	—	—
NC.	3.20	(14.99)	—	—
PC.	3.62	(16.92)	—	—
NPC.	4.06	(18.97)	—	—
L.S.Ds.	0.71*	—	0.49**;	0.68***

NOTE.—Figures in brackets are yields of green material per acre.

A detailed discussion of results is not recorded here since a full report will be completed for publication during 1956. Vigorous establishment of the Napier grass was greatly assisted by the application of phosphatic fertilizer and by cattle manure. Nitrogenous fertilizer did not have a significant effect on the yields of the first post-establishment cut.

The first full crop yields, harvested after the short rains, showed significant responses to all three treatments, though the phosphatic fertilizer and cattle manure treatments were residual from the long rains application. Yields with different treatment combinations were generally of a simple additive nature. The effect of the cattle manure is attributed primarily to its phosphorus content and to its physical effect on the soil in maintaining a more open soil surface.

Chemical Weed Control in Coffee

The full-scale yield trial described in last year's Annual Report (*Ann. Rept.*, 1954, pt. II, p. 130) was continued during 1955 and further results were recorded in detail in a second progress report (*Coffee Board of Kenya Monthly Bulletin*, 1955, 20, 151). Interim recommendations for the field application of P.C.P. weed-killer to control weeds growing through coffee mulches were also published in the *Coffee Board of Kenya Monthly Bulletin*, 1955, 20, 182. Therefore, summarizing the results obtained since the end of 1954, no chemical taint has been found in the coffee liquors from the 1954/55 season crop, and it is considered that results have been encouraging in respect of the future use of 2½ lb. per acre of P.C.P. per application for controlling weed growth through mulch in the coffee interrows.

Yield results from the trial for the 1954/55 and 1955/56 crop season are given in Table XII.

Table XII.—*Coffee Yields (cwt. clean coffee per acre)*

Treatment	CROP SEASON	
	1954/55	1955/56
(1)	1.99	14.56
2, 4-D*	1.25	15.40
2, 4-D* (Pro)	1.06	15.19
P.C.P.	1.13	16.78
P.C.P. (Pro)	1.20	16.41
P.C.P. + 2, 4-D	2.28	17.72
P.C.P. + 2, 4-D (Pro)	1.94	17.57
Normal Estate†	—	17.58

NOTES—

*For the above 2, 4-D treatments in the 1955/56 season, a C.I.P.C. weedkiller formulation was substituted.

†Normal Estate weeding; slashing tall weeds by hand labour.

(Pro) refers to application with a spray lance protected with a canopy to prevent spray drift.

The 1954/55 season was a low cropping season, and treatment yields were not significantly different. In the 1955/56 crop season, control and 2, 4-D, i.e. C.I.P.C., treatments were ineffective in controlling weed growth. Yield results were therefore grouped for ineffective versus effective treatments in the trial and the mean figures were 15.04 and 17.21 cwt. clean coffee per acre respectively. (This difference is significant at the 5 per cent point.) In the same season, normal estate weed control practice permitted cropping at the same level as good chemical weed control treatments, when both results are compared with the effects on yield of unrestricted weed growth in the control plots. This result is in accord with yield data from previous cultivation trials carried out on this station. (Pereira, H. C., and Jones, P. A., *Emp. J. Exptl. Agric.*, 1954, 22, 231). P.C.P. plus 2, 4-D (at 2½ lb. and 1 lb. acid equivalent per acre respectively) and P.C.P. alone gave, in that order, the best degree of weed control during 1955.

Reference to the influence of the degree of weed growth present in the unweeded and P.C.P. + 2, 4-D spray weeded plots of this trial has been made already. This difference could be observed in the leaf colour of the coffee in respective plots (see p. 107, Table IV).

The disturbing feature of the 1955 results was the presence of a chemical taint in coffee liquors from this trial. The liquoring report, prepared by Mr. C. R. Devonshire, coffee liquorer to the Coffee Board of Kenya, was scored for the remarks concerning chemical taint, and the results were checked by statistical analysis. A maximum of ten points was assigned to the highest quality liquors, and points were decreased as the general quality decreased, and when taints were noted.

Table XIII.—Coffee Liquoring. Chemical Taint Score

Treatment	Mean Score (of 9)†	L.S.Ds.
(1)	8.3	
C.I.P.C.	9.0	
C.I.P.C. (Pro)	9.0	
P.C.P.	9.2	0.54*
P.C.P. (Pro)	4.7**	
P.C.P. + 2, 4-D	8.2	0.74**
P.C.P. + 2, 4-D (Pro)	7.1**	
Normal Estate	8.4	

NOTE.—†The nine replicates were made up of three sub-samples from each treatment in three field replications.

A chemical taint referred to by the liquorer as a "bricky" type of flavour was associated with the use of P.C.P. and further, with the use of a protected spray lance. Spray drift was not apparently a cause of the taint which probably resulted from root uptake of the chemical or a breakdown product.

Sprays were applied to weeds on bare soil as well as weeds growing through mulch, and the trial will be modified in 1956 by splitting the plots for spray application to weed growth in mulched inter rows only versus weed growth in mulched inter rows and the bare soil areas around the trees. Further, as the C.I.P.C. treatment was ineffectivite this is being replaced by a "Dowpon" + 2, 4-D treatment in the trial.

Other weedkilling materials which were under preliminary test during 1955 were C.M.U. (80 per cent) and Dalapon (85 per cent wettable formulation) now renamed "Dowpon", both at rates of 5 lb. per acre. Results were encouraging in terms of weed kill with C.M.U., but as 2, 4-D was not added to the Dalapon, dicotyledonous weeds were not effectively controlled. Future work will feature "Dowpon" + 2, 4-D mixtures, C.M.U. as a pre-weed emergence treatment at low application rates and the use of Maleic Hydrazide to curtail the degree of weed growth.

Miscellaneous Investigations

MINERAL NUTRITION OF COFFEE: MAGNESIUM

The small survey trial consisting of ten pairs of trees, five pairs of which received Epsom-salt at the rate of 40 lb. per acre in 1954, was continued during 1955. A further application of Epsom-salt was made in April, 1955, and five sets of leaf samples were taken between June and December. The analysis of these samples has not yet been completed.

Yield results were again recorded, and the mean data for both the 1954/55 and the 1955/56 crop seasons are given in Table XIV.

Table XIV.—Yield (cwt. cherry per acre). Means of 5

				(1)	Mg.	L.S.Ds.
1954/55	..	..	..	60.42	74.25	No significant difference 5% = 19.23
1955/56	..	..	..	37.17	17.43	

Repeated field observations on leaf colour and visual evidence of crop strain have failed to indicate any clear difference between the treatments in this respect. Crop yields were adversely affected in the second year of magnesium salt application, but a possible explanation will depend on an interpretation of the leaf analysis results. The trial will be continued in 1956.

GREEN VEIN CHLOROSIS: IRON

Early in 1955 a small supply of chelated plant nutrients was received for experimental purposes, among which were the iron chelates of ethylene-diamine-tetra-acetic acid (E.D.T.A.) designated NaFe, and diethylene-triamine-penta-acetic acid (D.T.P.A.) designated Chelate Fe 330. These were compared with a solution of ferrous sulphate for effectiveness in the correction of green vein chlorosis symptoms (*E. Afr. agric. J.*, 1955, 20, 195) on mature coffee tree foliage.

Summarizing the results of a large number of replicated observations it was found that:—

- (a) When using the half-leaf virus scarification technique, 0.5 per cent w/v Chelate Fe 330 solution was similar in its effect to 0.25 per cent w/v ferrous sulphate solution, and both were more satisfactory than 0.5 per cent w/v NaFe solution. All solutions contained 0.1 per cent v/v of Teepol. The chelated iron solutions were easier to prepare and more stable than the ferrous sulphate solution. All three materials effected a "greening-up" of the chlorosed half leaf.
- (b) Straightforward spray application of ferrous sulphate and Chelate Fe 330 solutions to upper versus lower coffee leaf surfaces showed that a good effect could only be obtained when the underleaf surface received a good spray cover. Ferrous sulphate sprayed on to the upper surface of chlorosed leaves had no visible effect, and the Chelate Fe 330 solution only a very slight visible effect.
- (c) The incorporation of an experimental sticker with the three solutions as noted in (a) above, to determine whether more rapid effects could be obtained with a straight spray application were not very satisfactory. With young chlorosed leaf growth ferrous sulphate plus the sticker produced very severe leaf scorch symptoms and eventual leaf death. In the absence of the sticker "greening-up" of the leaf took place as expected. There was some adverse reaction with the sticker and both of the chelated iron solutions, and "greening-up" was not so satisfactory. It was concluded that, among other factors, the use of this experimental sticker (Plant Protection experimental Sticker YF 3198) blocked the uptake of the iron sprays by the leaf.

- (d) Finally, tests were carried out to examine the compatibility of a proprietary copper fungicide material with a ferrous sulphate and a Chel. Fe 330 solution applied to chlorosed foliage. The application of the iron nutrient with routine copper sprays would effect a saving in the field work if both could be applied in one operation. The concentration of the copper material was at the 2 per cent anti-leaf-fall level. In the presence of the copper material no "greening-up" effect of the leaf was observed with either source of iron.

At the present time the effects of soil applications of NaFe and Chel. Fe 330 to mature coffee trees exhibiting symptoms of green vein chlorosis are being observed.

A TRIAL WITH KRILIUM SOIL CONDITIONER IN THE COFFEE NURSERY

The deterioration in vigour and general health of coffee seedlings which has on occasion been noted in coffee nurseries after a number of seedling crops have been grown, may be attributed variously to the decreased fertility of the beds and/or to a run-down of the soil structure condition. At the Coffee Research Station cattle manure is applied to nursery beds at the time of making up, and at intervals thereafter between seedling crops, and yet it has been noted that vigor declines with time.

In 1954 a new nursery site was selected on the Kikuyu red loam soil and beds were prepared for planting. The opportunity was taken to put down an observation trial in which seedling condition would be compared under treatments of mulch and Krilium soil conditioner ("Merloam" formulation marketed by Monsanto (Soil Conditioners) Limited and supplied by the local agents). The bed was first prepared in the normal manner, which included a heavy application of good quality cattle manure forked well into the top 18 in. of soil. After the experimental treatments had been applied, the bed was managed in exactly the same way as the rest of the nursery.

Two replications of the following four treatments were put down, (a) control, no other treatment than normal nursery practice, (b) a mulch cover of fine grass between the rows of coffee seedlings, (c) Krilium soil treatment to a depth of 3 in. at the recommended rate of 1 lb./16 sq. ft., and (d) Krilium soil treatment to a depth of 6 in. at the recommended rate of 1 lb./8 sq. ft. The nursery bed was 5 ft. 6 in. wide, and the seedlings (all of one variety of *arabica* coffee) were planted 8 in. $\times$ 8 in. square. A single plot contained five rows of eight seedlings per row or 40 coffee seedlings. Treatments were randomized into two blocks.

The Krilium soil conditioner was applied in the following manner; the top-soil was lightly forked over before half of the total application was applied by sprinkling on to the soil surface. This was then forked into the required depth, i.e. 3 in. or 6 in., before the second half of the total Krilium dressing was applied in like manner.

Records were kept of the monthly seedling height over a full 12-month period. After the first six months alternate rows of seedlings, and the plot guard rows, were removed by cutting off at ground level and were weighed after drying. The remaining seedlings were left at a regular spacing of 8 in. $\times$ 16 in. At the end of 12 months the seedlings were carefully dug up and cut at ground level. Tops and roots were then dried and weighed. The trial was started in August, 1954, and completed in August, 1955, and the results of the first seedling crop are summarized in Table XV.

Table XV.—Growth Measurements of Coffee Seedlings

Factor Measured	Mean No. of Seedlings	TREATMENTS			
		(1)	Mulch	K 3 in.	K 6 in.
Wt. of aerial portion of seedlings after 12 months (gms. D.M.)	48	72.0	74.6	80.3	66.9
Wt. of root portion of seedlings after 12 months (gms. D.M.)	48	14.1	14.6	15.8	14.0
Ratio Root : Top ..		1 : 5.10	1 : 5.10	1 : 5.10	1 : 4.78
Increase in seedling height above ground level over 12 month period (cm.) ..	48	57.1	59.1	62.3	57.2

None of the results were significantly different for the treatments, but there is a consistent trend in favour of the Kriliun application to the top 3 in. of soil, and an indication that the 6-in. application has reduced aerial growth. Further seedling plantings will be made on these plots when it is expected that any real beneficial effects will be more apparent with time.

A COMPARISON OF PHOSPHATIC FERTILIZER TYPES ON THE KIKUYU RED LOAM SOIL

Under the section on Napier grass in this report the first year's results are given of a trial in which double superphosphate, hyperphosphate reno and basic slag are compared in the presence and absence of nitrogen fertilizer (Table VIII). A similar type of trial was carried out on two other sites where the crops were: (a) silage maize in the long rains, and white haricot beans in the short rains; and (b) permanent pasture grasses.

SILAGE MAIZE TRIAL

Three replications of a randomized block layout were put down at the beginning of the long rains, 1955. Treatments and yields are noted in Tables XVI to XIX; the plot size is 1/180th of an acre and the spacing used was standard for maize silage, i.e. 6 in. in the row, 2 ft. between rows. The bean crop was planted in the short rains, 1955, at a spacing of 2 ft. $\times$ 6 in. within the row. The phosphatic fertilizer treatments were applied in the planting hole with the maize crop, and the ammonium sulphate fertilizer was applied as a top dressing three weeks after planting. No phosphatic fertilizer was applied to the bean crop, but the ammonium sulphate treatment was repeated as a top dressing after germination.

Table XVI.—Silage Maize Yields (Long Rains, 1955)

Treatment	Dry Matter Yield. Tons per acre (Means of 3)	
(1)	1.28	(12.00)
N (1 cwt./acre ammonium sulphate)	1.17	(10.98)
Ps (100 lb./acre double superphosphate)	2.02	(18.95)
P.b.s. (292 lb./acre basic slag)	1.53	(14.35)
P.h.r. (145 lb./acre hyperphosphate reno)	1.21	(11.35)
N.Ps	1.66	(15.57)
N.P.b.s.	1.61	(15.10)
N.P.h.r.	1.39	(13.04)
L.S.Ds.	0.39*	(3.66)*
	0.54**	(5.07)**

Table XVII.—Two-way Table illustrating Phosphatic Fertilizer Effects

				DRY MATTER YIELD (TONS PER ACRE)				MEANS OF 12
				(1)	Ps	P.b.s.	P.h.r.	
(1)	..	..	..	1.28	2.02	1.53	1.21	1.51
N	..	..	..	1.17	1.66	1.61	1.39	1.21
Means of 6	..	..	..	1.22	1.84	1.57	1.30	
L.S.Ds.				0.28*;		0.38**		

NOTES—

Maize planted 26th March, 1955; harvested 1st June, 1955.

Results in brackets (Table XVI) are Green Matter Yields.

Despite the fact that the maize silage was cut prematurely because of the incidence of leaf rust and lodging, a substantial yield increase resulted from the application of double superphosphate, and there was a lesser yield with basic slag. No response was obtained to hyperphosphate reno or to the nitrogen application.

The results of the short rains bean crop are noted in Table XVIII. Yields were very low because of poor rainfall distribution.

Table XVIII.—White Haricot Beans (Short Rains, 1955)

Treatments				Yield of Threshed Beans. lb. per acre (Means of 3)
(1)	..	..	..	153.1
N	..	..	..	166.4
Ps (residual)	..	..	..	180.5
P.b.s. (residual)	..	..	..	210.7
P.h.r. (residual)	..	..	..	185.1
M.Ps	..	..	..	199.4
N.P.b.s.	..	..	..	209.8
N.P.h.r.	..	..	..	162.5
L.S.D.s	..	..	..	38.7*

Table XIX.—Two-way Table illustrating Residual Phosphatic Fertilizer Effects
Yield of Threshed Beans—lb. per acre

				(1)	Ps.	P.b.s.	P.h.r.	Means of 12
(1)	..	..	..	135.1	180.5	210.7	185.1	182.3
N	..	..	..	166.4	199.4	209.8	162.5	184.5
Means of 6	..	..	..	159.7	189.9	210.2	173.8	
L.S.Ds.	..	..	..	27.2*				

NOTE.—Beans planted 25th October, 1955; harvested 3rd February, 1956.

Although the yields were small the residual double superphosphate and basic slag fertilizers have increased the yields significantly, but in this case the basic slag residual treatment has had the greater effect. Again neither the hyperphosphate reno nor the ammonium sulphate fertilizers have increased yields. This trial will be continued.

PERMANENT PASTURE GRASS

Three blocks of three different grass species in the observation grass plots were used to investigate the responses to the three types of phosphatic fertilizer. No manurial treatments were applied to these plots when they were established, or since that time (1950). Cultivation by hand has been carried out after each rainy season when cutting is finished.

In the long rains, 1955, phosphatic fertilizers only were applied, broadcast between the rows. The three replicated blocks consist of three separate grass species, and the consideration of results has been confined to the observation of large general responses to the fertilizer types. The individual plot size was very small, being only 1/222nd of an acre.

Table XX.—Grass Yields. Tons Green Material per acre

Treatments	MEAN OF THREE GRASS SPECIES*	
	Long Rains	Short Rains†
(1)	5.46	4.76
Ps. (100 lb./acre double superphosphate)	5.16	3.94
P.b.s. (292 lb./acre basic slag)	4.56	3.44
P.h.r. (145 lb./acre hyperphosphate reno)	5.66	5.09

NOTES—

**P. maximum* var. *trichoglume*, *Bothriochloa Insculpta*, and *Setaria* sp. ex Nandi.

†The phosphatic fertilizer treatments were residual only in the short rains.

No apparent responses to the fertilizers have yet been recorded. It was observed that during the long rains pale foliage colour, attributed to a nitrogen shortage, was general. In the short rains, therefore, a blanket dressing of ammonium sulphate, at the rate of 1 cwt. per acre, was applied. This trial will be continued.

THE RAPID DETERMINATION OF MOISTURE IN PARCHMENT COFFEE

In this section of the Annual Report, 1954, Part II, p. 135, details were given of a vacuum oven drying technique which was developed as a standard reference method for coffee moisture determination. During the 1955/56 crop season two electrical moisture meters and one hair hygrometer dial reading instrument were tested for accuracy and reproducibility of readings and an attempt was made to calibrate results against the standard vacuum oven method. With the increased interest and activity which is being shown in artificial coffee drying, it is important to have a reliable and rapid method of determining moisture in parchment coffee in the field as well as in the laboratory.

A full report of this work has been completed and submitted to the Coffee Processing Sub-Committee and only the main conclusions and findings are given here.

The instruments tested were:—

- (1) A 6-volt accumulator-operated N.P.L. Baldwin moisture meter.
- (2) A dry-battery-operated Marconi moisture meter with a large-size cell.
- (3) A dial-reading hygrometer instrument, Opancol type, O.T.2.

The N.P.L. Baldwin moisture meter operating over the range of 50 per cent down to 8 per cent moisture content was not satisfactory. The calculated standard deviation of the difference between the true moisture content and that found with the meter was ± 4.3 per cent.

The Marconi meter operating with a large cell and a single layer of unground parchment beans, was also unsatisfactory. The relationship between the meter reading and the standard moisture content was not a straight line in these tests. This meter again showed promise if samples were ground before each determination, but this is not practical at high coffee moisture contents, nor is it a desirable feature of a "field operated" instrument. Assuming a straight line relationship for purposes of calculation, the standard deviation of the difference (with whole beans in a large-size cell) between the true moisture content and that found with the meter, was ± 2.8 per cent.

The Opancol, O.T.2, instrument operated effectively over the range 18 per cent down to 8 per cent moisture content in these tests. It was concluded that this instrument would be of value, particularly in conditioning bin installations, for determining the desired end point moisture content. It was found to be necessary to keep the instrument in the shade for outdoor determinations with parchment coffee on sun-drying tables as large temperature variations influence the readings quite markedly.

Whilst this work was being undertaken the East African Industrial Research Organization was testing the Toplis and Simpson "Kappa" moisture meter (electrically operated), and the tests were very satisfactory. The model examined was mains operated and it remains to confirm these results on a portable battery-operated model suitable for use in the field.

THE INVESTIGATION OF PINEAPPLE "YELLOW" AND ITS CONTROL

In collaboration with Mr. H. R. Evans, Assistant Agricultural Officer (Hort.), who is stationed at the Coffee Research Station, field diagnosis, field trial and pot experiments have been initiated to study means of controlling this condition which is of widespread occurrence in the industry, particularly where the crop is being grown on the red Kikuyu loam soil.

Final results are not available at the present time but it appears that a combination spray of iron and manganese, preferably in the chelated nutrient form, or a soil application of the same materials, will bring about "greening up" of the foliage, or will prevent the appearance of the symptoms. No really suitable injection technique for field diagnosis work has been found yet, but the application of nutrient solutions by simply spraying them on to the foliage would seem to be quite efficacious.

In one pot experiment which has been concluded, three replications of a 2×6 factorial layout, results for true root and rhizome plus top weights (Table XXI), although not statistically significant, were in substantial agreement with observed differences between foliage colour in relation to treatments.

Table XXI.—Pineapple Pot Experiment (Dry weight in gms. per plant)

Soil Treatment	True Roots (Means of 6)	Rhizome and Tops (Means of 6)	Degree of yellowing on leaves
(1)	2.43	5.49	Very yellow
Iron Complex	2.10	6.08	Yellow
Fe Chelate	3.15	9.02	Green
Mn Chelate	3.33	8.16	Green
F.T.E.	2.60	7.47	Pale yellowish- green
Fe and Mn Chelate ..	2.60	9.28	Green

The growth period was six months. Uniform planting material (tops) were used. The soil was a Kikuyu red loam topsoil (0-9 in.) collected from a pineapple field and all treatments were soil applications.

F.T.E. is a fritted glass material containing iron, manganese, copper, boron, molybdenum and zinc; the iron complex is an industrial byproduct containing iron lignin sulphonate. It seems likely that over a longer period of growth, e.g. field conditions, the effect of F.T.E. material would be greater than it was in this short-term test. In the pot test it had an intermediate influence on the control of the "yellows" symptom, and on the final growth condition of the plants.

Acknowledgments

I have received assistance with various aspects of the work reported here from a number of persons. I would like particularly to acknowledge the help of Mr. C. R. Devonshire, Liquorer, The Coffee Board of Kenya, Mr. H. H. J. de Vink, Assistant Agricultural Officer (Experiments), Coffee Research Station, and latterly Mr. I. R. Wallace who took over the duties from him. Finally, there has been the excellent standard of the laboratory work carried out by Mr. D. Mwae, Laboratory Assistant.

Publications

- (1) A Cultivation System for Ground-Water (Vlei) Soils, *E. Afr. agric. J.*, 1955, 21, 69.
- (2) Second Progress Report on Chemical Control of Weeds in Coffee. *Bull. Coff. Bd. Kenya*, 1955, 20, 151.
- (3) Chemical Weed Control in mulched Coffee Inter-rows. *Bull. Coff. Bd. Kenya*, 1955, 20, 151.
- (4) Chemical Control of Weeds in Coffee. *Pest Abs. and News Summ.* Sect. C., 1956, 2, 3.

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GRASSLAND RESEARCH—ANNUAL REPORT FOR 1955

Introduction

The staff position improved towards the end of the year with the gradual release of some officers from the security forces. Early in 1956, the remainder will be released, and thus bring the staff up to full strength once more.

The organization consists of the main station at Kitale, at 6,200 ft., with five pasture research officers and a chemist, together with a farm manager, and technical staff to assist in all branches of the work. The sub-station at Molo, at 9,000 ft., has one pasture research officer and is to have a farm manager as soon as the house is finished.

Three other substations are planned, for which the pasture research officers have now been recruited, and are already in training. Two of these are to be in the African semi-arid areas, one in the Rift Valley Province and the other in the Southern Province. Their main concern will be: (a) the restoration of denuded and overgrazed areas; (b) grassland management; (c) bush control; and (d) the use of leys under marginal conditions. The third station will be concerned with the European ranching areas.

Funds for capital equipment and development have been made available during the year, and these were most helpful and welcome.

The general policy underlying the work of the station is: (a) the provision of the maximum amount of high quality herbage throughout the year; (b) the maintenance or raising of soil fertility by means of good grassland management; and (c) the development of a sound farming system, based on the results of the experiments which have been carried out.

Good progress has been made in these three directions during the year, and the results are briefly described in later sections of this report.

To achieve the objects mentioned above, the work on the station is organized accordingly. The plant introduction work aims not only at testing new species, but particularly to find improved varieties of the species in present use, as farming experience shows that they all suffer various minor drawbacks, such as stemminess, insufficient persistence, uneven seed ripening and other faults. This work, carried out by Mr. A. V. Bogdan, concludes at the stage of small field scale plots under intensive grazing, in order to eliminate all those which are less productive and least persistent.

The next stage, done by Mr. R. Strange, after the bulking up of seed of the more promising species and strains, is their intensive testing in critical field experiments to investigate establishment, management, seed production, dry season production, response to fertilizers, and finally their persistence and production under large scale grazing tests.

Work is concurrently carried out by Dr. R. G. Poultney on the effects of grasses and grass-legume mixtures on soil fertility, and also the effect of ley management on soil fertility.

Investigations on the effect of the legume on the grass, and in nitrogen fixation and nodulation are carried out by Dr. E. D. Bumpus.

The work in these two latter sections is planned to fit in with the general herbage agronomy work, so that the work of each branch gives the best possible assistance to all other branches.

When species have come through these various lines of investigation satisfactorily, they are then tested on a large-scale rotation in 10-acre fields, so that they can be properly judged on a field scale.

Another line of work, which tests the performance of selected species and varieties on a wider scale, is the co-operative experiments programme. In this, an officer carries out trials on anything up to 20 farms in the district with different soil and rainfall conditions, to ascertain the productivity and persistence of the herbage plants under a wide variety of conditions. They are then finally subjected to the test of evaluation by means of animal production, which is done by Mr. E. M. Kidner. This ensures that the species and varieties which give the best live weight increase in beef cattle, and later on in milk production, are the ones finally selected for general use, and are also the ones to put into the seed certification scheme which is now coming into operation.

In all this work the Pasture Research Chemist, Dr. H. W. Dougall, assists with chemical analysis, wherever it is required, and the work is arranged so that the whole pasture research team contributes to the solution of the problems in hand.

Weather and Rainfall

The rainfall over most of the Colony was above average during the year, but the year's total at Kitale was 40.72 in. compared with the mean which is 46 in. The first three months of the rainy season, i.e. April, May and June, had a rather low and erratic rainfall, and in June particularly, distribution was so poor that the maize and experimental plots hardly grew at all, but nevertheless they managed to survive, and in this respect we were more fortunate than many other farms in the Trans Nzoia.

The rainfall month by month, together with the number of rainy days, is given in the table below, with the two previous years for comparison.

Table I

Month	1955		1954		1953	
	Rainfall	No. of days	Rainfall	No. of days	Rainfall	No. of days
	<i>in.</i>		<i>in.</i>		<i>in.</i>	
January ..	1.76	6	0.24	2	0.14	1
February ..	1.23	6	1.17	3	0.16	1
March ..	0.45	4	3.26	7	0.50	4
April ..	3.49	17	4.80	15	5.84	18
May ..	4.44	13	5.52	22	7.23	12
June ..	3.19	14	4.59	16	6.86	21
July ..	4.58	22	5.31	18	3.26	16
August ..	6.18	21	5.71	25	5.89	15
September ..	6.28	24	5.28	14	1.20	7
October ..	2.83	14	1.69	12	3.32	16
November ..	1.42	12	1.45	5	1.85	14
December ..	4.87	11	2.32	6	1.02	8
Totals ..	40.72	164	41.34	145	37.27	133

Annual mean rainfall for Kitale = 46 in.

WORK AT KITALE

(1) Plant Introduction and Nursery Work

This work forms the basis of all our efforts in the improvement of herbage plants. In the case of Rhodes and Molasses grasses, which are in general use already, the aim is to obtain varieties superior to those in present use. Rhodes grass can with advantage be improved in a number of respects such as productivity, sward-forming capacity, persistence, a better leaf-stem ratio, a decreased tendency to run to seed heads in the early growing season, and more even ripening of seed. The best varieties were named in last year's report, and further good ones which have come to light are varieties from Venezuela, the United States of America, and from Mpwapwa in Tanganyika. These, together with the others, are being tested in the preliminary grazing trials, and the one which seems to be about the best so far is from Mbarara in Uganda. In due course, the best three or four varieties will be subjected to critical comparisons in field experiments, and in co-operative experiments, as well as by means of animal production trials, to ensure that the best available variety is finally chosen. Those on the short list at present seem to be superior to the Nzoia strain, which is therefore likely to be superseded in due course.

Molasses grass is being dealt with in the same way as Rhodes grass. At one time it was thought that this species offered little scope for improvement, but it has become apparent that the strains differ considerably from one another, and the best ones will therefore be selected for further critical comparison. This species seems to be particularly well suited to the Trans Nzoia district and also certain of the higher altitudes in the high rainfall mixed farming areas. In the field grazing trials at Kitale, it has been interesting to observe that Kenya white clover can be very aggressive towards molasses grass if the sward is kept too short, and may almost overrun the grass. A good balance can, however, be maintained if the sward is kept longer, at a height of about 9-12 in.

A number of varieties of *Paspalum dilatatum* are being compared, and also *P. malacophyllum* and *P. regnellii*. While these can be established from seed, their early growth is slow after germination, which renders them susceptible to weed competition. The genus *Paspalum*, however, is probably about the most likely source of new grass species for agricultural use under our conditions, being a genus of over 200 species, mainly from tropical America. Three species of the genus *Urochloa* were tried, with no satisfactory result, and it seems unlikely that this genus will provide much of value.

Eleven varieties of elephant (Napier) grass are being compared under field conditions, and so far none of them seem to be superior to the Cameroons and Gold Coast varieties.

Guinea grass varieties (*Panicum maximum*) are being selected for purposes of dry season pastures, and the finer ones for general purpose pastures for the rainy season.

Star grass (*Cynodon dactylon*) has been tested for some time, to try and obtain productive varieties with no rhizomes, combined with adequate leaf and good seed-producing qualities. It is the latter which presents the most difficulty, and so far a really good combination has not been found, though a number of seeding types are now available.

Makarikari grass (*Panicum coloratum* var. *makarikariensis*) has been tried in Kenya for some years now, but the varieties tested produced hardly any flower or seed. Two recent introductions from Southern Rhodesia have, however, produced viable seed and both were successfully grown from seed in small plots.

This species shows possibilities for use in the semi-arid area of the Colony. Grasses for these conditions will be tried out in future at the two sub-stations in the semi-arid areas, so that they can be tested under the conditions for which they will be required.

A collection of 32 varieties of Kenya white clover (*Trifolium semipilosum*) shows that there is very wide variation in this species, in size of plants, vigour, flower colour and season of growth. Some types also show susceptibility to what appears to be a virus disease which causes dwarfing together with foliar growths in the inflorescence and no setting of seed.

A variety of the common white clover (*Trifolium repens*) from Louisiana has persisted for three years now and flowers and sets seed well, and also has tall flower stems very suitable for combine harvesting. It seems a particularly promising variety and is coming into large-scale tests and field grazing trials in the coming season. Work on varieties of subterranean clover and also on inoculants has made all the difference to the performance of this species. A suitable variety, supplied with the right strain of inoculant (and not the same one as for white clover) and also supplied with a moderate dressing of double superphosphate (1 cwt. per acre) shows up as a most productive herbage plant. It is now going into preliminary grazing trials, to test its persistence and production under intensive grazing in a mixture with a ley grass.

The lucerne collection has now been built up to 122 different varieties, with a view to finding the variety or varieties best suited to Kenya, out of all the available ones. They have been obtained from Australia, America, India, Iraq, Turkey, North Africa and elsewhere. Out of these, a short list of 16 has so far been selected, and these are to be compared, in order to find the best ones from the point of view of resistance to leaf-spot disease, drought resistance, productivity and seed production.

The number of different herbage plant samples in the nursery is just over 1,000, and includes grasses of all types, legumes, fodder shrubs and perennial ever-green herbs suitable for grazing and inclusion in leys.

Thirty-five acres are devoted to seed production plots, and from these, the various experiments and trials on the grassland and other experimental stations in the department are supplied.

The lack of sufficient suitable grass species in parts of the Colony indicates the importance of the plant introduction work.

(2) Species for Leys

There is little to add to last year's report on species for leys. Field-scale trials have been carried out with Kenya white clover (*T. semipilosum*) as a constituent of leys, but much more work still needs to be done before an accurate appraisal of its value for leys can be made. One of the troubles in field trials so far is that the inoculant was slow in working and nodules appeared too late in the season to have any noticeable effect. Many of the clover plants were greenish-yellow in colour, showing the lack of effective nitrogen fixation. Work at the Scott Laboratories has resulted in obtaining more efficient strains of *Rhizobium* for this species, and this may make a considerable difference to the clover in the mixture. *Trifolium rueppellianum* has made some good looking and compatible mixtures with Nandi *Setaria* in observation plots. The problems involved in maintaining such mixtures need further investigation before they can be put into wider use.

Two grass species which are being examined for use as ley species, namely thin-stemmed Guinea grass (*Panicum maximum* var. *trichoglume*) and signal grass (*Brachiaria brizantha*) have still not proved satisfactory for larger scale trials. It may be that further selection and other work may yet enable them to be used for general purpose leys.

Star grass (*Cynodon dactylon*) is eminently suitable for use in leys, but its widespread use is held up by lack of leafy varieties which seed well.

There are four kinds of grass ley in use at present, which may be classified as follows:—

(i) *General Purpose Leys*.—These are the ones commonly used during the rainy season for grazing purposes. In the flush season they can be used for a silage cut if necessary, and later in the season, except for molasses grass, they can be used for hay. The main species concerned are Rhodes grass, molasses grass, Nandi *Setaria* (*Setaria sphacelata*) and star grass (*Cynodon dactylon*), and among legumes, lucerne, Kenya white clover, and probably certain other species too.

(ii) *Special or Late Season Leys*.—Their particular function is to provide good quality herbage at a time when the general purpose leys have become lignified and fibrous and gone off in quality and production. It is possible that in due course they may be similar to our dry season leys, but in the present state of our knowledge they seem to have a place. The species which have given good results so far are Nandi *Setaria* and lucerne in alternate rows about 2 ft. apart. Such a mixture is much more productive than lucerne alone. These rows can be kept clean, and the wide spacing makes for economy in the use of soil moisture. The yields of fresh material provided by such mixtures are:—

Table II.—Fresh Yields in Tons per Acre

	1954	1955	Total 2 seasons
	Tons	Tons	Tons
Lucerne alone	6.6	9.8	16.4
Lucerne plus Nandi <i>Setaria</i>	13.5	15.0	28.5
Increase over Lucerne alone	6.9	5.2	12.1

(iii) *Dry Season Leys*.—As their name implies, they are designed expressly for the production of green herbage in the dry season when conditions are not suitable for the growth of the species in the other kinds. The grasses concerned in these are elephant (Napier) grass, Guinea grass and *Setaria splendida*. The drawback to the use of these alone is their low nutritive value, and every effort has been made to find suitable legumes for inclusion either in the grass rows, or in between them. Three perennial *Dolichos* species were used for this, and *Dolichos* ex Kilima Kiu and *D. lablab* (perennial) were good in the first year, but succumbed to competition from the elephant grass at the end of the second year. *D. biflorus*, while both persistent and productive, appears to be somewhat bitter and not palatable unless very young. Fortunately, however, we still have further species available which may serve the purpose, and there are other ways of combining the grass and legume which need investigation. The chemists advise that there is not only a protein shortage at this time, but a deficiency of carbohydrates also, and both these foodstuffs need to be catered for if a well-balanced production diet is to be provided.

(iv) *Seed Production Leys*.—The main object of these, as indicated, is the production of seed. Some early season or aftermath grazing may be available if it does not interfere with seed yields. Present indications, however, are that early season grazing tends to reduce yields of seed, but the matter needs further investigation.

Rhodes grass, molasses grass and Nandi *Setaria* are about the only species to be used in this way so far.

(3) Establishment of Leys

A trial was carried out to compare the merits of direct seeding a ley grass (i.e. alone) compared to seeding the grass with a grazing companion crop of oats. The results are given in Table III below:—

Table III.—Total Green Yields in 1954 and 1955 in Tons per Acre

Year	SEEDED WITH OATS FOR GRAZING			SEEDED ALONE		
	Nandi <i>Setaria</i>	Nzoia Rhodes	Molasses grass	Nandi <i>Setaria</i>	Nzoia Rhodes	Molasses grass
1954 Est. year	15.9	15.8	16.2	3.5	2.7	3.3
1955 ..	9.6	5.9	8.3	10.3	4.6	7.8
Total ..	25.5	21.7	24.5	13.8	7.3	11.1

The figures for seeding with the oat companion crop includes the yield of oats. These results demonstrate the substantial increase obtainable in the way of grazing material by the use of a companion crop in the establishment year (1954) which amounted to a four- or five-fold increase. In the following year, the yields from the two treatments of the same species had reached about the same level.

During 1954, two co-operative trials were put down, one at Eldoret and one at Kipkabus, in order to assess the relative value of undersowing, direct seeding and companion seeding, for the establishment of general purpose leys. Rhodes, molasses and Nandi *Setaria* were used in both trials, each being (a) undersown in wheat for a grain crop, (b) companion seeded with oats as a grazing companion crop, and (c) sown alone.

In the year following establishment, growth of the leys was about equal, irrespective of the establishment technique used. These trials therefore show that undersowing, which is probably the most popular method, is a satisfactory technique from the point of view of the ley. It should be noted, however, that the yield of the cover crop, i.e. of the wheat, is sometimes reduced by undersowing. More information is still needed on the extent of the reduction of the wheat and maize crops as a result of undersowing.

(4) Management of Leys

An experiment was carried out to compare four different systems of management on a Rhodes grass ley, to see how they affected production and, in due course, soil fertility. The four treatments were management for hay, grazing, silage and seed production. Under farming conditions these would not, of course, be used continuously, but it is desirable to know what sort of cumulative effect they have on the sward and on fertility, if used frequently. The mean dry matter production per acre per annum has been: hay, 3 tons 19 cwt.; grazing, 4 tons 17 cwt.; silage, 5 tons 6 cwt.; and aftermath following seed production, 4 tons 2 cwt. The interesting point is that after two seasons, the hay and silage treatments are becoming unproductive and dying out in patches which are becoming invaded by annual weeds.

These are the trends to date, but the experiment is to continue further.

Another experiment was carried out to investigate the effect of grazing intensity on the herbage output of grazing leys. It has frequently been thought that the English practice of close and frequent rotational grazing, suitable for perennial ryegrass, may not necessarily be the best for the bigger tropical herbage plants which need to be able to grow taller to provide adequate ground cover. The following experiment tends to confirm this.

The four grasses, Rhodes, molasses, Guinea and Nandi *Setaria*, were sown with clover and lucerne, and the treatments and grazing days per acre are given in the table below:—

Table IV.—Number of Grazing Days During 1955 (Establishment Year)

Treatment	No. of grazings	Total grazing days per acre
1. Grazing a tall growth of herbage, no mowing ..	3	294
2. Grazing as in (1) and mow residue after each grazing..	2	124
3. Cut first flush for silage, then grazing as in (1) ..	2	159
4. Graze when young, and mow after each grazing ..	3	192

The height of mowing was about 5 in.

Results and observations indicate that frequent grazing at the young stage, followed by close mowing, tends to reduce the vigour of the pasture. Further experiments on these lines are necessary.

The management of dry season leys is receiving much consideration, and so far work has been concerned with problems of spacing, cultivation and fertilizer treatment, and yields have been worked out as production per annum.

In future, management during the rains will be arranged with a view to increasing the level of the yields in the dry season, and species and managements must obviously be compared on the basis of production in the dry season months only. The main difficulty about this is the varying number of rainshowers or even wet spells in the "dry" season, some being typically dry, and others, as in 1955–1956, unusually wet for the time of year.

The following table gives the yield of six species during the dry season, cut in January, when the rainfall in preceding months was: November, 1.45 in., December 2.32 in., and January, 1.76 in.

Table V

Species	Tons Dry Matter	
	Tons	cwt.
<i>Setaria splendida</i> ..	2	6
Elephant grass ..	1	1½
Guinea grass ..	1	7½
<i>Beckeropsis unisetia</i> ..	0	18½
Perennial <i>Sorghum</i> ..	0	6½
<i>Hyparrhenia hirta</i> ..	1	8

In previous experiments with elephant grass in 1953-54, the amounts of dry matter per acre per annum obtained varied from 3.5 to 7.5 tons.

These figures show what sort of general level of production one can hope for, but, as mentioned previously, the quality as regards protein and carbohydrate is not very high at this time of year, and this problem also needs attention.

(5) Experiments on Natural Grassland

This experiment was started in 1954 with the object of finding out to what extent it was possible to improve the production of natural grassland by means of fertilizers, singly or combined. A 3^3 factorial design was used, with sulphate of ammonia at 0, $2\frac{1}{2}$ and 5 cwt./acre, double superphosphate at 0, $1\frac{1}{2}$ and 3 cwt./acre, and common salt at 0, $2\frac{1}{2}$ and 5 cwt./acre. The latter treatment was included, as the chemists advise that the soil is low in exchangeable sodium. The experiment is not yet complete, but some of the yield figures are given in the table below.

Table VI.—Yields of Dry Matter (Mean Yield per Acre per Annum)

					Increase over control	% increase
Control ($N_0P_0S_0$)	= 4 tons	2 cwt.	..	..	—	—
$N_1P_1S_0$	..	= 6 tons	10 cwt.	..	+ 2 tons 8 cwt.	58
$N_2P_2S_0$	..	= 8 tons	17 cwt.	..	+ 4 tons 15 cwt.	116
$N_0P_0S_2$	..	= 4 tons	17 cwt.	..	+ 0 tons 15 cwt.	18
$N_2P_2S_2$	..	= 6 tons	2 cwt.	..	+ 2 tons 0 cwt.	49
$N_1P_2S_0$	..	= 7 tons	6 cwt.	..	+ 3 tons 4 cwt.	78
$N_2P_1S_1$	..	= 7 tons	12 cwt.	..	+ 3 tons 10 cwt.	85
$N_0P_2S_2$	..	= 3 tons	10 cwt.	..	— 0 tons 12 cwt.	—14
$N_0P_2S_0$	..	= 4 tons	14 cwt.	..	+ 0 tons 12 cwt.	14

(N=sulphate of ammonia, P=double superphosphate, and S=salt;
0=none, 1=medium rate and 2=high rate of application.)

The vegetation was mainly *Hyparrhenia filipendula* and *Loudetia kagarensis* before the experiment began, but in plots which have received sulphate of ammonia, these grasses have been mostly replaced by various *Setaria* species, e.g. *S. trinervia*, which are generally more useful and productive.

(6) Effect of Fertilizers and Manures

The results for two seasons are now available, of the effects of fertilizers on elephant grass production through the year including both dry and wet seasons. The design of the experiment was a 2^5 factorial arrangement. The elephant grass was put in in rows 6 ft. apart and 3 ft. between plants in the rows with *Dolichos* Kilima Kiu between plants in the rows, but the latter has tended to die out in the second season. It declined from 32 per cent down to 5 per cent by weight of the mixture.

Table VII.—Dry Matter Yields (Tons per Acre), 1954 (Establishment Year)

Treatment			Control's	Main Effects
S/A:	1.9	..	1.7	Plus 0.2
Supers:	2.0	..	1.5	Plus 0.5
Potash:	1.7	..	1.8	Minus 0.1
Lime:	1.7	..	1.7	Nil
Green manure:	1.7	..	1.7	Nil

Table VIII.—Yields of Dry Matter in Tons per Acre, 1955

Treatment				Controls	Main Effects
S/A:	4.2	..		3.1	Plus 1.1
Supers:	3.9	..		3.4	Plus 0.5
Potash:	3.6	..		3.7	Minus 0.1
Lime:	3.7	..		3.6	Plus 0.1
Green manure:	3.7	..		3.6	Plus 0.1

It will be observed that, as usual, the only fertilizers to produce any effects were the nitrogenous and phosphatic ones. The 1955 dressings were sulphate of ammonia 6 cwt.; with 2 cwt. at the start of the season and 2 cwt. after each cut; double supers $1\frac{1}{2}$ cwt., muriate of potash 2 cwt., and the green manure consisted of lupins dug in. Lime was applied at the beginning of the experiment only, at $2\frac{1}{2}$ tons per acre.

A fertilizer experiment on lucerne has given interesting results. The arrangement was a 2^5 factorial design with sulphate of ammonia at $1\frac{1}{2}$ cwt. per acre, double superphosphate 2 cwt., muriate of potash 2 cwt., lime 4 tons and farmyard manure at 10 tons per acre. With the exception of the sulphate of ammonia, all treatments gave statistically significant increases in yield. This is the first positive response to lime and potash so far obtained at Kitale with any crop, and is therefore of particular interest. Further confirmation is, of course, desirable.

(7) Inoculation and Nodulation of Legumes

An experiment was carried out with subterranean clover, to ascertain the effect of phosphates and inoculant on the development of nodules, chemical composition of the plant, and production. As this clover and its *Rhizobium* are not indigenous to the soils of Kenya, the effect of inoculation shows up very strongly. After about four to six weeks, the inoculated plots go ahead very rapidly in growth rate and produce much stronger plants and a dark green colour. The effect of 1 cwt. per acre of double superphosphate is also very pronounced, and the effect of supers plus the inoculant, compared with the control, having neither, is exceedingly striking.

The crude protein content and mean yields under the various treatments are shown below:—

Table IX
Per cent Crude Protein

					No inoculant	Inoculated	Mean
With phosphate	..	..	..	..	14.24	19.44	16.84
No phosphate	..	..	..	..	13.98	17.62	15.80
Mean	..	..	..	..	14.11	18.53	

Yields (Fresh Weights) per Plot

					Inoculated	No inoculant	Mean
					lb.	lb.	lb.
With phosphate	..	..	..	..	179	62	120.5
No phosphate	..	..	..	..	34	18	26
Mean	..	..	..	..	101.5	40	

It will be noticed that there is almost a tenfold difference between plots receiving phosphate and inoculant, and those receiving neither.

Other legumes have not yet shown the same degree of response to inoculant as subterranean clover has on this station. At Eldoret, however, blue and yellow lupins showed a striking response.

In other experiments carried out at Kitale, a comparison was made between the weights of nodulated and unnodulated plants in a series of plots of the same species. The mean percentage increases in weight of nodulated over unnodulated plants for the four species concerned were as follows:—

	Per cent
<i>Alysicarpus glumaceus</i>	200
<i>Teramnus labialis</i>	27
<i>Trifolium semipilosum</i>	24
<i>Medicago sativa</i> (Lucerne)	57

Comparisons were also made between the mean weight of nodulated and unnodulated plants in the plots for each species, by means of the "t" test. Seven species gave significant results for the "t" test and details are given in the table below:—

Table X

Species	No. of Plots	Level of Significance
1. <i>Alysicarpus glumaceus</i> (indigenous)	11	P=0.001
2. <i>Teramnus labialis</i> (indigenous)	23	P=0.02
3. <i>Trifolium semipilosum</i> (Kenya white clover)	13	P=0.01
4. <i>Medicago sativa</i> (Lucerne)	24	P=0.05
5. <i>Lupinus albus</i> (white bitter Lupin)	7	P=0.02
6. <i>Trifolium subterraneum</i> (Mt. Barker)	4	P=0.02
7. <i>Trifolium usambarense</i> (a local annual clover)	3	P=0.02

The evidence so far indicates that effective nitrogen fixation does take place in a number of legumes, both indigenous and introduced ones.

The next stage in our work seems to be to find the conditions necessary to enable the grass to benefit from the associated legume. Experiments have been planned accordingly for the coming season.

(8) Seed Production

Experimental work on molasses grass seed production shows that grazing may reduce the yield of seed considerably, as shown in the following table:—

Table XI.—Yield of Molasses Grass Seed, lb./acre, 1955 (Mean of 16 Plots)

Date of harvest	Yield from plots grazed up to 1st June	Yield from plots with no grazing
	lb.	lb.
18-7-55	—	82
7-9-55	—	96
15-9-55	13	—
3-11-55	—	85
28-11-55	121	—
Totals	134 lb./acre	263 lb./acre

A 3rd factorial experiment on the seed production of Nzoia Rhodes grass and the effects of three spacings (3, 4 and 5 ft. between rows), of 0, 1 and 3 cwt. sulphate of ammonia per acre, and of 0, 1½ and 3 cwt. double supers per acre, show that there is a considerable drop in the seed yield in the third year. The wider spacings between the rows are still apparently the best, and there is a strong effect from both nitrogen and phosphate, and an interaction between the two. In the first two seasons, 1 cwt. of supers and 2 cwt. of sulphate of ammonia seem to give about the most economic returns.

Two factorial experiments on a 2nd design were carried out on seed production of Nandi *Setaria* and Alego Rhodes grass, a more stoloniferous form than Nzoia Rhodes. The treatments were the application of nitrogen and phosphate at 4 cwt. and ¼ cwt. respectively per acre per annum and potash and lime at 4 cwt. and 2½ tons per acre respectively at the beginning of the experiment only. The fifth treatment was broadcast v. sowing in 3-ft. rows. 1955 results are summarized below:—

Table XII—Nandi *Setaria*, 1955 Seed Production
Lb./Acre, Total of 2 Harvests

Treatment			Controls	Treatment Effects
N	= 200	..	186	Plus 14 lb./acre
P	= 196	..	191	Plus 5 lb./acre
K	= 203	..	188	Plus 15 lb./acre
Lime	= 194	..	193	Plus 1 lb./acre
Cultivation	= 207	..	Broadcast 180	Plus 27 lb./acre

The increases are small compared with results from Nzoia Rhodes grass in the past.

Table XIII.—Alego Rhodes, 1955 Seed Production
Lb./acre from 3 Harvests

Treatment			Controls	Treatment Effects
N	= 153	..	75	Plus 78 lb./acre
P	= 128	..	103	Plus 25 lb./acre
K	= 124	..	107	Plus 17 lb./acre
Lime	= 123	..	108	Plus 15 lb./acre
Cultivation	= 135	..	96	Plus 39 lb./acre

In this experiment nitrogen, phosphate and cultivation have given the best increases, and this is in accordance with previous experience with Rhodes grass seed production.

(9) Seed Certification

It is most satisfactory to be able to report that a seeds Ordinance has now been passed, and that a scheme for the certification of grass seeds is to go ahead. The first species to go into the scheme is Nandi *Setaria*. The foundation plant plots are on the Kitale station, and this year most of the mother seed is also to be produced here.

Arrangements are going ahead for the growing of certified seed in the Trans Nzoia district, where a number of enthusiastic farmers have formed their own organization for the purpose. It is hoped that suitable arrangements will also be made in other parts of the Colony.

It will be operated as a pilot scheme for the next year or two, after which it is hoped to operate it on a larger scale when the teething troubles have been dealt with.

The next species to go into the scheme will probably be molasses grass and Rhodes grass, when work on the evaluation of the best available strains has progressed further.

REPORT OF THE PASTURE RESEARCH CHEMIST

(1) The Determination of "Crude Fibre"

Work on this subject was begun in 1954 and completed during the present year.

In the estimation of crude fibre at altitudes appreciably above sea-level, it is necessary to correct for lowered boiling points of reagents and consequent reduced speeds of reaction. When Todd (*Nature*, 1951) estimated crude fibre in ten samples of plant materials at sea-level and at 6,200 ft., he calculated the percentage error involved in each instance and proposed three ways of correcting, namely: (1) by increasing the duration of the boiling; (2) by increasing the concentration of acid and alkali; (3) by carrying out the estimation by the standard procedure and applying a correction factor.

An examination of the first proposal was begun in Nairobi in 1954, at the Scott Agricultural Laboratories (5,700 ft.). Twelve samples of plant materials of varying fibre content were digested with 1.25 per cent acid and with 1.25 per cent alkali for periods of 15, 30, 45, 60, 90 and 180 min. Results showed that there is a highly significant inverse relationship between the logarithm of the time allowed for digestion and the resulting crude fibre fraction of the material. In Nairobi the reagents boiled at 94.3°C., and a digestion period of 45 min. gave crude fibre values which did not differ significantly from those obtained by the conventional 30 min. digestion at sea-level; a calculated digestion period of 45.6 min. appeared to give optimum correlation.

The following equation was evolved to correct for lowered boiling points at higher altitudes by increasing the duration of the digestion period:—

Time of digestion (min.) = $30 \times 10^{(100^\circ - t^\circ) 0.032}$, where $t^\circ\text{C}$ is the boiling point of the reagents.

Alternatively, the following regression equation to correct the conventional 30-min. digestion value was found to be:—

Crude fibre (corrected) = crude fibre (30 min. at $t^\circ\text{C}$) $\times [1 - (100^\circ - t^\circ) 0.0102]$.

FURTHER WORK ON THE DETERMINATION OF "CRUDE FIBRE"

It is a valid criticism of the conventional procedure for estimating the crude fibre of plant materials that during the digestion with 1.25 per cent alkali, lignin is extensively though variably removed (Norman, *J. Agric. Sci.*, 1935). Since the

"lignin fraction" exercises a direct effect on the digestibility of animal foodstuffs (for it is the fraction that remains almost entirely non-digested by animals), it is generally considered desirable that any empirical method for the determination of crude fibre should ensure that all the lignin is retained in this fraction. Such a method would automatically exclude the use of an alkaline digestion.

Preliminary work with the eventual object of seeking an alternative to the conventional "crude fibre" determination has begun. Experiments on *Symphytum peregrinum* (Russian comfrey), *Setaria splendida* and *Trifolium semipilosum* show that—

(i) the alkaline digestion, which forms the second part of the conventional method, produces a marked effect on the residue that resists the acid digestion, viz.—

Plant Material	Digestion with 1.25 per cent H ₂ SO ₄	Digestion alternately with 1.25 per cent H ₂ SO ₄ and 1.25 per cent NaOH
	Resulting Fraction (per cent of dry matter)	
<i>Symphytum</i> ..	48.21	10.31
<i>Setaria</i> ..	51.95	29.54
<i>Trifolium</i> ..	49.81	22.17

(ii) digestion with acid alone ($1.5 NH_4SO_4$), i.e. acid of approximately six times the strength of that used in the standard procedure, produces in the same plant materials a "crude fibre fraction" that decreases logarithmically with the time allowed for digestion, viz.—

Time allowed for digestion with 1.5 N. H_2SO_4 (hr.)	Resulting "crude fibre"—per cent of dry matter		
	<i>Symphytum</i>	<i>Setaria</i>	<i>Trifolium</i>
$\frac{1}{2}$	41.39	42.65	45.67
1	39.15	40.35	42.72
$1\frac{1}{2}$	36.66	38.82	40.29
2	35.27	38.44	38.45
$2\frac{1}{2}$	34.23	37.99	38.22
3	32.41	37.20	37.69

(2) (a) The Analysis of Fodder Shrubs

It has been stated as a humbling thought that probably more animals feed on shrubs and trees, or on associations in which shrubs and trees play an important part, than on true grass or grass-legume pastures, short and tall-grass ranges, and steppes. A beginning has been made to assemble data on such fodder shrubs as are known to be well-liked by stock. (See Table XIV, page 135.)

Acalypha wilkensiana is a plant native to Melanesia. It is called "copper leaf" and is widely cultivated in gardens as an ornamental shrub. Its leaves are rich in

protein of very high digestibility. They are not fibrous and they are an excellent source of calcium and phosphorus. The pods of *Acacia sieberiana* are a good source of protein, but they are very fibrous and not a particularly good source of minerals. The leaves of *Inula decipiens* are coarse and not at all attractive; they are extremely siliceous, and it is not surprising that the protein is of relatively slow digestibility. On the other hand, they are obviously an excellent source of calcium. *Diplophium africanum* is a good source of protein and of minerals, especially calcium, and it is not fibrous.

(2) (b) The Analysis of "Herbs"

A number of "herbs" were sown in July at 2 lb. per acre with molasses grass at 10 lb. per acre. The grass/herb ley was grazed for the first time during the second week in October, and the individual herbs were sampled for analysis before the animals were allowed to graze. The results of the analysis are given in Table XV, page 136.

These herbs are a good source of protein and, with the exception of chicory, the protein is of high digestibility. None of the plants are fibrous. They are all well supplied with calcium, and provide a reasonably good source of phosphorus. It is estimated by the National Research Council of the United States of America that a cow weighing 10 cwt. requires 11 g. P. daily for maintenance and 7 g. P. daily for the production of one gallon of milk. On this basis, the phosphorus content of the chicory is adequate to provide for maintenance and two gallons of milk.

(3) Seasonal Variation in the Composition of Nandi Setaria

Samples of Nandi *Setaria* (*S. sphacelata*), were obtained at weekly intervals for about eight months, from a pure stand of this grass that had been established at Njoro in 1954. In order that the seasonal trend in its composition may be seen clearly, the results which follow are given after intervals of approximately one month:—

Date Sampled	COMPOSITION—PER CENT OF DRY MATTER						
	Ash	Crude Protein	Ether Ex- tractives	Crude Fibre	N-free Ex- tractives	Ca	P
18-8-54 ..	13.75	20.00	2.93	28.05	35.27	0.32	0.23
1-9-54 ..	14.23	19.43	2.71	27.24	36.39	0.31	0.20
6-10-54 ..	12.12	14.93	3.28	29.05	40.62	0.29	0.17
3-11-54 ..	10.98	13.35	2.30	31.31	42.06	0.31	0.14
1-12-54 ..	9.14	8.86	2.03	31.55	48.42	0.31	0.10
5-1-55 ..	11.95	8.58	2.08	31.14	47.25	0.34	0.07
2-2-55 ..	9.98	6.86	1.59	33.18	48.39	0.31	0.07
2-3-55 ..	12.38	11.87	2.74	27.17	45.84	0.39	0.13

Table XIV.—Composition of Fodder Shrubs—Per cent of Dry Matter

Fodder Plant	Ash	Silica	Crude Protein	Percentage Digest. of Crude Protein	True Protein	Ether Extrac-tives	Crude Fibre	N-free Extrac-tives	Ca	P
1. <i>Acalypha wilken-siana</i> (leaves) ..	12.33	n.d.	15.96	84.59	14.56	3.97	11.95	55.79	2.03	0.72
2. <i>Acacia sieberiana</i> (pods)	4.02	0.005	11.62	69.28	6.80	1.43	40.24	42.69	0.10	0.14
3. <i>Inula decipiens</i> (leaves) ..	34.99	24.04	7.84	39.80	6.62	2.45	28.69	26.03	1.52	0.25
4. <i>Sesbania</i> (leaves)	7.57	0.10	25.97	63.03	17.52	2.64	14.39	49.43	1.11	0.27
5. <i>Diplopodium africanum</i> — (1-ft. high) ..	13.85	0.12	17.71	84.92	16.10	2.81	13.68	51.95	1.11	0.45
(In full flower)	10.36	n.d.	13.15	n.d.	n.d.	5.04	14.43	57.02	2.10	0.24
(Tassels only)	9.89	n.d.	10.76	80.58	9.13	4.45	16.92	57.98	2.10	0.17

Table XV.—Composition of Herbs—Per cent of Dry Matter

Herb	Ash	Silica	Crude Protein	Percentage Digest. of Crude Protein	True Protein	Ether Extrac-tives	Crude Fibre	N-free Extrac-tives	Ca	P
Burnet	10.10	0.07	18.88	84.96	17.76	3.37	11.88	55.77	0.99	0.31
Chicory	15.87	0.01	13.81	60.54	12.49	2.88	13.85	53.59	1.56	0.23
Caraway	15.81	0.56	13.47	80.55	12.84	1.95	13.31	55.46	0.92	0.43
Plantain	12.90	0.15	15.93	76.02	12.25	2.18	13.34	55.65	1.54	0.29
Yarrow	15.25	1.85	19.28	76.45	16.32	1.90	14.71	48.86	1.05	0.32

These data show clearly that as the season advances, the crude protein fraction of the *Setaria* decreases markedly, but that by March (and the onset of the 1955 rains) this fraction begins to rise. The phosphorus moves in sympathy with the crude protein and follows precisely the same seasonal trend, while concomitantly the nitrogen-free extractives follow the directly opposite trend and reach their highest value in the grass when the crude protein is at its lowest. It is noted also that as the nitrogen-free extract fraction increases, the grass tends to become more fibrous.

MOLO GRASSLAND AND RESEARCH SUB-STATION

This station is situated at about 9,000 ft. and serves the high altitude areas where conditions are entirely different from those at Kitale. During the year, 59.47 in. of rain were recorded compared to the annual average which is between 45 and 50 in.

Trifolium johnstonii is an indigenous perennial clover which is being tested for use in leys at Molo. A fertilizer experiment on herbage production in this species has shown strong significant responses to lime and double superphosphate, especially the latter, and also a lime, phosphate interaction. It is a shy seeder in the first year, but does fairly well in the following season. Among grass species, Westerwolths ryegrass is still showing up very well as a short-term ley grass, and *Phalaris tuberosa* seems to be a promising species for longer leys.

The fertilizer experiment on lucerne confirms previous findings, that strong positive responses are obtained both to phosphate and to lime, and that good nodules were only found in plots which received lime.

In the vlei nursery, the results obtained from the use of lime were also confirmed. The Cocksfoot, ryegrass and Timothy varieties were best when limed, while the ones which did reasonably well on the unlimed plots were Italian ryegrass and Yorkshire fog.

A number of experiments were carried out, trying various methods of ley establishment. As pointed out before, on old arable land, weeds are liable to become very troublesome when establishing leys, and definite measures have to be taken to deal with the weeds, particularly spurrey (*Spergula arvensis*).

An experiment to determine the establishment of S.24 perennial ryegrass and *Trifolium johnstonii* under oats, on old dirty land, gave the following results: where there was a high seeding rate of oats (Lampton), the weeds had been suppressed nearly as much as in the spraying treatments (four pints per acre of Agroxone "3"). 40 per cent of the yield on the unsprayed, low seed rate oat plots was just weeds, with only traces of weeds in all other treatments.

Two other experiments on ley establishment showed that (a) the undersowing of barley with perennial ryegrass seems to work well on clean land in good heart, and (b) the undersowing of Equator II wheat by S.143 Cocksfoot is satisfactory with adequate rainfall.

In a factorial experiment ($3 \times 3 \times 3$) on the establishment of perennial ryegrass, using three rates of seeding, of phosphate and of Agroxone "3" herbicide spray to control spurrey, the results confirm previous work that the herbicide at four pints per acre is beneficial in controlling the spurrey and assisting establishment of the grass. About 300 lb. of superphosphate and seed at 20 lb. per acre gave the best results. When the weather is cloudy the herbicide seems to be more toxic than in warmer and drier weather.

In another experiment on perennial ryegrass, of similar design, the treatments tested were three rates of spraying Agroxone "3", three times of spraying, and three rates of top dressing with sulphate of ammonia. Results showed that successive increments of 2 cwt./acre of sulphate of ammonia increased grass yields by nearly 4 cwt. per acre of air dry matter, at the same time decreasing weed growth. The spray rate and spray time results confirm those of 1953 and show the importance of correct time of spraying in relation to weed growth. In this experiment the spray at two pints per acre gave the most economic response.

Work on grass seed production shows that the Welsh "S" strains of perennial ryegrass hardly flower at all, Italian ryegrass, however, seems to flower and seed normally. In Cocksfoot, the strains S.37, S.26, Scotica, Dunn's M.S. and Dunn's P.P. flower very little, S.143 flowers moderately, while Olsgaard and Dunn's Early-flowering are heavy seeders.

Publications During 1955

(1) Bogdan, A. V., "Herbage Plants at the Grassland Research Station, Kitale, Kenya". *East African Agricultural Journal*, Vol. XX, No. 3, pp. 151-165, January, 1955.

(2) Bumpus, E. D., "Grassland Research Progress in Kenya (1954)". *Journal of the Royal Agricultural Society of Kenya*, No. 7, August, 1955.

(3) Dougall, H. W., "Fertilizers for Ley Establishment, Existing Leys and Selected Pastures". *Journal of the Royal Agricultural Society of Kenya*, No. 8, November, 1955.

(4) Dougall, H. W., "Correction of 'Crude-Fibre' Estimation for the Effect of Altitude". *Nature*, Vol. 175, 28th May, 1955.

(5) Strange, L. R. N., "Forage Legumes for Medium Altitudes in Kenya". *East African Agricultural Journal*, Vol. XX, No. 4, April, 1955.

(6) Strange, L. R. N., "The Management and Utilization of Temporary Leys at Medium Altitudes". *Journal of the Royal Agricultural Society of Kenya*, No. 6, May, 1955.

(7) Strange, L. R. N., "The Management of Permanent Pasture in the High Rainfall Mixed Farming Areas". *Journal of the Royal Agricultural Society of Kenya*, No. 7, August, 1955.

Acknowledgments

I am very glad of the opportunity to acknowledge the excellent work done by all members of the staff who were with us during the year. The absence of five of our members with the security forces added a big extra load to those who carried on with the work meanwhile, and I am most grateful to all those who put in so much extra time and effort to see the programme through. The good work done by the African Field Assistants and other African staff is also very much to be commended.

E. D. BUMPUS,
Senior Pasture Research Officer.

ANNUAL REPORT OF THE SENIOR HORTICULTURAL OFFICER FOR 1955

Introduction

There is no doubt that canning and other forms of processing of horticultural produce offer the best means of developing the horticultural industry on a large scale in Kenya. During 1955 therefore, the work of the horticultural section was concentrated more on the crops which are being grown for canning and on those which are potentially suitable for this purpose. A tremendous amount of work remains to be done, not only on the production of canning crops and the suitability of different areas for the purpose, but on potential markets for our canned produce. Valuable co-operation is being given by the Colonial Products Laboratory in London in obtaining market reports on our canned produce and in suggesting how improvements in the various packs can be achieved. This organization is also assisting us by preparing market information on the possibilities of exporting certain fresh products by air to the United Kingdom.

The Senior Horticultural Officer made a study tour of the South African pineapple industry before proceeding on vacation leave. This tour forms the subject of a separate report. During the tour, the opportunity was taken of visiting research institutes and growers of other horticultural crops in the Union.

Citrus

SURVEY OF COASTAL CITRUS

The main investigational work at Matuga during 1955 was a survey of citrus in the Coast Province, carried out by Mrs. S. M. Wheatley. Owing to restrictions in space, only a short summary can be included in this Annual Report, but it is hoped that the full account of the survey will be published elsewhere.

The principal objects of the survey were as follows: to estimate the number of existing citrus trees, their yield and quality; to determine the soil and climatic factors best suited for citrus growing and to observe the effect of existing cultural practices; the selection of outstanding seedlings as seed parents; and the investigation of existing methods of marketing and marketing potential.

In one year it is not possible to investigate all the above points fully, but much useful information has been collected which should form a basis for future work and enable some policy to be formulated for the development of citrus in the Coast Province. The existing seedling trees are estimated to number about 40,000. At a standard spacing of 75 trees per acre, the total acreage would be 533. The different kinds are estimated to be: oranges 31,400, grapefruit 1,800, lemons 3,400, limes 2,200, tangerines 1,600. Soil and climatic conditions are the most important factors limiting successful citrus growing, with origin of planting material and cultural practices coming next. By the law of the survival of the fittest, the large concentrations of citrus are found on two main soil types, the Magarini sands and the Kambe limestone, but only where rainfall is adequate. The rainfall which is adequate to support growth of citrus at the coast is not sufficient to produce regular heavy crops, and the possibilities of developing irrigation appear to be few. Much could be done, however, to improve yields and quality of fruit by improved cultural practices, such as adequate spacing, mulching and pest control.

The yield varies very considerably from year to year, largely depending on the rainfall. A recorded orange tree at Junju, for example, yielded 2,050 fruits in 1953/54, 415 in 1954/55 and 1,030 in 1955/56. Number of fruits per lb. for the three seasons was 2.5, 2.0 and 2.5 respectively. An average yield of the better trees in the more favourable areas can be estimated at 800 fruits per annum, but the average for the whole Province is unlikely to exceed 400 fruits.

The prices of citrus fruits in Mombasa fluctuate not only from month to month but from day to day. The better quality mature fruits will sell at a wholesale price of Sh. 4 and a retail price of Sh. 8 per 100 fruits during a glut, whereas towards the end of a season the price may rise to Sh. 8 wholesale and Sh. 15 retail. Poor quality fruit has a depressing effect on the price of the better quality product. The present marketing "system" is chaotic, with the grower at a disadvantage amongst a host of middlemen.

Factors which have a depressing effect on prices are: harvesting of immature fruit by growers with an urgent need for cash; disorganized arrival of fruit at the market which often results in a glut one week and a shortage the next; extreme carelessness in harvesting, handling and packing, which results in heavy wastage of fruit; lack of grading and artificial colouring of the fruit.

Although there would be an increased outlet for a better grown and marketed Coast orange on the fresh-fruit market, the special qualities of the fruit, probably make it more suitable for juice production. The development of an orange juice industry would however depend on the development of export markets.

RUIRU

Measurement of the girth of all trees has confirmed that at Ruiru the irrigated trees have continued to make more growth than the unirrigated trees. Most of the trees are now almost five years old from time of planting and the difference in appearance of tree size and habit is quite marked.

Generally, the unirrigated trees are more compact than the irrigated trees, which are much taller, but the growths are more straggling, this is especially so of the lemons. Irrigation amount varies according to the rainfall, but the irrigation policy is to maintain an even moisture level at all seasons of the year. Rainfall amounts up to 1 in. are ignored. The total rainfall for the year was 30.08 in. and the irrigation amount was at the rate of 20.0 in. per acre per year. The amount given at each irrigation is at the rate of 2.5 in. per acre. Fruiting of the 1951 citrus plantings was prevented until 1955, to enable the trees to become well established and better able to withstand heavy cropping. The mean yield results over three trees of each treatment are as follows:—

Table 1

Species	Variety	IRRIGATED			UNIRRIGATED		
		Mean No. fruit per tree	Mean weight per fruit	Mean Yield per tree	Mean No. fruit per tree	Mean weight per fruit	Mean Yield per tree
			oz.	lb.		oz.	lb.
Orange ..	Washington Navel	7.3	9.5	4.85	7.6	8.0	3.17
"	Renmark Navel ..	7.6	7.7	3.66	36.0	5.8	14.40
"	Valencia Late ..	3.3	7.4	1.55	29.0	6.1	11.23
"	Lue Gim Gong ..	3.5	6.5	1.37	50.6	4.7	14.91
"	Temple ..	16.3	9.4	9.67	33.3	8.3	17.00
"	Sabina ..	37.3	3.6	8.50	73.0	4.8	21.91
Tangerine ..	Satsuma ..	37.6	4.0	9.50	16.0	4.1	4.16
Grapefruit	Marsh's Seedless	23.0	8.9	12.83	60.3	9.2	34.83
"	Triumph Seeded ..	11.3	5.9	4.13	42.3	7.8	10.66
"	Triumph Seedless	8.0	6.7	3.41	3.0	5.3	1.0
Lemon ..	Eureka ..	64.3	6.6	26.91	162.0	6.1	61.46
"	Lisbon ..	5.0	7.6	2.10	226.0	4.7	68.75
"	Villa Franca ..	111.0	6.9	48.00	257.0	7.8	126.83
Avocado ..	Fuerte ..	Nil	Nil	Nil	54.6	11.8	40.46

The yield results show, except in four instances, the superiority of the unirrigated yields. In the case of avocados, the yield results of the irrigated trees may be a reflection of the biennial bearing habit of the tree. The 1953/54 avocado yields, which represented first cropping showed a mean yield for the irrigated trees of 44.0 lb. and for the unirrigated trees 16.5 lb. Though citrus yields are heavier for unirrigated trees, the mean fruit weight is less than for the irrigated trees.

Though the yield results from the two treatments are the reverse to that expected, it would be unwise at this stage to accept them as conclusive. One important feature of the irrigated versus unirrigated trees is that the unirrigated soil, under constant mulch, is capable of holding moisture for long periods.

On examining unirrigated mulched soil which had not received rain for just over two months, it was found that the soil was still quite moist at a depth of 1 ft. From observations in the field, the indications are that citrus requires dry soil conditions at some period during the year, preferably before the long rains season. Dry soil conditions, followed by rain, results in heavy blossoming. This has rarely been observed among the irrigated trees which are always showing signs of active growth and light flowering.

The results of these first-year yields indicate the need of a wide study of the irrigation requirements of sub-tropical tree fruits, when grown in an equatorial climate where winter temperatures are not low enough to induce a satisfactory rest period.

Artificial Colouring.—At Ruiru tests have been carried out with calcium carbide to see if oranges could be successfully coloured by acetylene gas. Fruit just turning colour were placed in a small chamber of 6 cu. ft. capacity. Half an ounce of calcium carbide was placed in a liberal amount of water in a small container. Recharging was carried out thrice daily. A total of 21 chargings was made before a satisfactory colour improvement was achieved. Colour change was observed on the second day and increased very slowly thereafter until the ninth day when the fruit were removed from the chamber. Shortly after removal it was noticed that the colour became deeper and more attractive than the paler yellow colour which was induced by gassing. The greater the colour amount in the fruit before treatment, the less time taken to induce colour. Fruit must be quite dry before gassing, otherwise mould develops with resultant high fruit losses in the chamber.

Grapefruit and lemons have also been successfully coloured in the same way as the oranges, but double the amount of carbide was necessary at each charging. It was also found that grapefruit could be artificially coloured by placing them in brown paper bags in a cool, airy store. Similar trials of the artificial colouring of oranges by means of acetylene gas have been carried out at the Coast, where the problem of poor skin colour is much more acute. The results were equally successful and the method is recommended for commercial use. The gas most generally used for this purpose is ethylene, but as it has to be specially imported in large and expensive cylinders, its use is likely to be considerably more expensive than acetylene, for small-scale operations.

At Molo lemons, oranges and grapefruit have been found to develop an excellent skin colour if the fruit is placed loose in boxes in the fruit storage cellar for a period of about six weeks. The air temperature is 50–55° F., and high humidity is maintained.

Pineapples

Owing to Emergency conditions in Kiambu it has not been possible to attain the target acreage in that area. Although the total tonnage exported from the district in 1955 is approximately the same as in 1954, about 5,000 tons, the yield per acre calculated on a bearing acreage of 1,700–1,800 acres, is slightly less than

3 tons. The extremely low yield per acre may be attributed to Emergency regulations, which resulted in growers being left with little time in which to cultivate their land, and to the fact that all new plantings are on bench terraces where soil fertility is usually too low for good results to be obtained with pineapples. The early plantings in Kiambu were mostly on newly broken hillsides and under these conditions good results were obtained without the use of manure or fertilizers. It is obvious that it would be useless to press for a large increase in acreage until a general improvement in cultural methods, including the use of adequate quantities of fertilizer or manure has raised the yield per acre to a reasonable level. Propaganda with this end in view has already been started.

In contrast to the somewhat depressing situation in the Kiambu native land unit, European growers in the settled areas of Kiambu and Thika have made considerable progress. Most growers have adopted the standard Hawaiian spacing of two-row beds at 3 ft. $\times$ 2 ft. $\times$ 1 ft., and the value of sulphate of ammonia as a fertilizer for pineapples is generally recognized. The system of planting on ridges or raised beds, initiated by Mr. J. Robinson (Soil Chemist, Coffee Services), is opening up large new areas of heavy, poorly drained soils which were previously thought to be of doubtful value for pineapple growing.

In Nyanza nine exploratory pineapple trials which were planted in the short rains, 1954, are beginning to ripen the plant crop. The first fruits from three of the trials have been analysed for sugar and acid. The figures obtained do not differ significantly from those given by Kelley in his analyses of smooth Cayenne fruits grown in Hawaii. Flavour, flesh texture and colour are generally good. A few cases of eye rot were noted, but the incidence was not serious. There appears to be a tendency for fruit of a rather conical shape to be produced at the 4,000-ft. level, no doubt due to high temperatures. The trials have already demonstrated that if pineapples are to be grown successfully in Nyanza, and this applies also to other producing areas, they must be planted on land which is in good heart, preferably land which has laid fallow for some years. If this is not done, considerable quantities of fertilizer or manure will have to be applied in order to produce good crops.

TRIALS AT THE COAST (KILIFI)

It is unfortunate that drought, the depredations of baboons and indiscriminate harvesting by estate labour have combined to make the yield records of these trials worthless. However, as pineapple canning has been discontinued in the area, due largely to unsuitable climatic conditions, the trials are not now considered to be of any great value.

Fertilizer and mulch trials under coco-nut tree shade and duplicated without shade. Commenced 1953. Treatments are three rates of nitrogen, two rates of phosphate, one rate of potash, and mulch.

Observations made during the year were as follows:—

In the unshaded part of the trial, the highest rate of nitrogen (12 lb. of sulphate of ammonia per 100 plants), combined with mulch, was the best treatment. Plots of this treatment showed the healthiest and most drought-resistant plants which carried the largest fruit.

The number of plants fruiting per plot was also highest for the harvesting season November, 1954–May, 1955. Phosphate and potash alone or combined had a slightly adverse effect on growth and cropping when compared with the control. The best treatment in the shaded part of the trial was the highest rate of nitrogen plus mulch plus phosphates. A second fertilizer and mulch trial, started in 1954, with treatments, three rates of nitrogen and mulch, has not yet fruited. Growth response, both under coco-nut shade and unshaded, has been greatest in the treatment, highest rate of nitrogen plus mulch.

It is interesting to note that the trials carried out at the Coast have produced quite different results with mulch to those carried out at Thika, an account of which follows. The beneficial effect of mulch on pineapples at the Coast is probably due partly to a reduction of high soil temperatures, and partly to conservation of moisture under drought conditions.

TRIALS IN THE THIKA AREA

Pineapples (Co-operative Experiments).—A 2⁴ factorial fertilizer trial designed to study the effects of nitrogen, iron, magnesium and a soil fumigant, ethylene dibromide has now produced its first ratoon crop. The results of the plant crop were published in the Annual Report for 1953.

The trial was commenced at Karamaini Estate, Thika, in April, 1951, and the planting material was fruit crowns. The spacing was in three-row beds with 9 ft. between the beds and 1 ft. × 2 ft. between the plants. Treatments were nitrogen as 2,000 lb. sulphate of ammonia per acre versus nil; magnesium versus nil; iron versus nil; and a post-planting soil fumigant, ethylene dibromide versus nil.

The first applications were made during December, 1951. Sulphate of ammonia being applied to the base of the leaves at the rate of 500 lb. per acre at bi-monthly intervals. Magnesium was applied in the form of a foliage spray at 2 per cent at monthly intervals over a period of five months.

Sulphate of iron was similarly applied, but in this case there were six applications. Ethylene dibromide was applied during May, 1952, as a single application in a 10 per cent concentration. Application was by means of a hand soil injector pump.

The first harvests of the first ratoon crop were made during September, 1954. Thus the time lapse between the final harvest of the plant crop and the first harvest of the ratoon crop was 11 months. The time taken to harvest the ratoon crop was 11 months though the time taken to harvest the plant crop was nine months.

A summary of the first ratoon crop results is as follows:—

Table II.—Mean Yields and No. of Pineapples per acre and average weight of Pineapples

Treatments	Tons per acre	No. fruit per acre	Mean weight per fruit
			lb.
(1)	10.80	7,326	3.22
N	13.93	8,658	3.75
D	8.08	5,328	3.40
Fe	12.06	7,992	3.35
Mg	14.07	8,991	3.65
ND	12.50	7,992	3.22
N Fe	14.87	9,657	3.32
N Mg	12.09	7,992	3.37
D Fe	7.74	5,328	2.77
D Mg	7.49	4,662	3.17
Fe Mg	12.73	7,659	3.75
D Fe Mg	7.60	4,899	3.33
N D Fe	11.42	8,325	2.92
N D Mg	9.65	6,660	3.05
N Fe Mg	11.64	6,993	3.37
N D Fe Mg	14.44	8,653	3.67

Mean Treatment Effects.—For any treatment or combination of treatments noted, the above figures are the mean difference for all treatments in the trial with and without the treatments concerned.

Table III.—Summary of the Significant Effects

Treatments					Yields per acre	No. fruit per acre	Average weight of fruit
					<i>tons</i>		<i>lb.</i>
N	..	..	..	..	+2.20**	+1,571**	—
D	..	..	..	..	-2.76**	-1,613**	-0.26**
Fe	..	..	..	..	—	+780*	—
Mg	..	..	..	..	—	—	+0.21*
ND	..	..	..	..	—	+780*	—
N Mg	..	..	..	..	-1.33*	—	—
Mg Fe	..	..	..	..	—	—	+0.25**
ND Fe	..	..	..	..	—	—	+0.17*
D Fe Mg	..	..	..	..	+1.60*	+760*	+0.20*
L.S.D. 5 per cent					1.25	736	0.16
1 per cent					1.67	986	0.22

Table III shows the highly significant residual effect of sulphate of ammonia on yields and number of fruit per acre. The highly significant depressing influence of the soil fumigant D, both on yields and numbers of fruits per acre, is also shown. Iron shows no favourable influence on either yields per acre or mean weight per fruit though there is a significant increase in the number of plants producing fruits. Magnesium has had a significant effect on mean weight per fruit though no favourable increase is noted in terms of yields or number of fruit per acre.

The interaction between sulphate of ammonia and magnesium has resulted in a significant decrease in yields while the interaction of magnesium and iron has had a highly significant influence on mean fruit weight.

A favourable interaction on fruit weight has also resulted from nitrogen, plus soil fumigant and iron, though here again there has been no favourable influence on yields or number of fruits per acre. The interaction, however, of the soil fumigant plus iron and magnesium has been significantly favourable on all three features, i.e. yields per acre, number of fruits per acre and mean fruit weight.

Table IV.—Calculation of Mean Yields and some Treatment Combinations from the Main Effects and Interactions

Treatments					Yields per acre	No. of fruit per acre
					<i>tons</i>	
N	..	..	..	..	13.70	8,642
D	..	..	..	..	8.74	5,479
Fe	..	..	..	..	—	8,267
ND	..	..	..	..	12.02	7,081
N Fe	..	..	..	..	—	9,079
Fe D	..	..	..	..	—	5,870
N Fe D	..	..	..	..	—	8,974
					*	†

*=Mean yield over Fe and no Fe.

†=Mean yield over Mg. and no Mg.

The results in Table IV show the superiority of the residual influence of sulphate of ammonia over the other treatments. The suppressing effect of ethylene dibromide might have been less if it had been applied earlier.

The 2.20 tons per acre superiority of the nitrogen over the nil treatment of 10.80 tons per acre is only 1.7 tons less than the yield per acre obtained from the plant crop. This continued relatively high yield increase shows the effective residual influence of nitrogen on plant vigour and fruit production. Not only was yield, in terms of tons per acre, maintained but fruit size was also maintained. This influence on fruit size as a result of the sulphate of ammonia treatment was 0.81 lb., less than the plant crop mean weight per fruit while the difference between the sulphate of ammonia and the nil treatment was 0.53 lb. The difference in the percentage of fruit of 4 lb. and over between the nitrogen and the nil treatment was also superior in the nitrogen treatment as may be seen in Table V.

Table V.—Per cent of Fruit of 4 lb. and over

Treatments			Per cent Fruit	Treatments			Per cent Fruit
(1)			18.0	Fe			25.0
N			43.0	Mg			45.0
D			34.0	—			—

The above table shows the single-factor influences on the production of fruit of 4 lb. and over. The highly significant influence of nitrogen and also magnesium on fruit weight has been maintained. The two factors produced a similar influence on fruit weight in the plant crop though the influence of magnesium was very much less on the plant crop.

The percentage of fruit of 4 lb and over was much higher from the soil fumigant treatment in this crop than it was in the plant crop when only 15 per cent of the fruit reached a weight of 4 lb. and over. This indicated that the suppressing influence of the soil fumigant was becoming less by the time the ratoon crop was harvested. Iron has again had little influence on fruit weight as it did in the plant crop, though here, too, the influence is much less than it was in the plant crop when only 9 per cent of the fruit was 4 lb or over.

Table VI shows the influence of nitrogen and ethylene dibromide on fruit harvesting.

Table VI.—Cumulative Percentages of Fruit Harvested Month by Month

Treatment			Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
(1)			3.0	14.0	Nil	19.0	27.0	50.0	61.0	Nil	Nil	62.0	73.0
N			5.0	28.0	Nil	35.0	36.0	58.0	75.0	76.0	77.0	78.0	86.0
D			8.0	25.0	Nil	30.0	31.0	41.0	44.0	45.0	47.0	50.0	54.0

Sulphate of ammonia again accelerated fruiting during the first four months of harvesting, as it did in the plant crop. The total percentage of fruit harvested from the three treatments was very much higher for the ratoon crop than it was for the plant crop. This may, to a large degree, be due to the fact that a large number of the hang-over plants from the plant crop produced fruit during the ratoon crop and consequently swelled the total numbers of plants producing fruit in the ratoon crop.

Summary.—The more important features of the first ratoon crop results are:—

- (1) That the residual effect of sulphate of ammonia was highly significant.
- (2) That the 2.20 tons of fruit produced as a result of the sulphate of ammonia treatment over the nil treatment is clear profit since the cost of the sulphate of ammonia was more than covered by the yield increase resulting from the nitrogen treatment effect on the plant crop yield.
- (3) That nitrogen maintained superiority over the other treatments.
- (4) A higher percentage of fruit of 4 lb. and over was produced as a result of the sulphate of ammonia application.
- (5) A larger number of plants produced fruit as a result of the sulphate of ammonia treatment.
- (6) Nitrogen accelerated fruiting during the first four months of the harvesting period.
- (7) Ethylene dibromide significantly depressed yields though there was a favourable interaction as a result of the nitrogen plus ethylene dibromide treatments.
- (8) More plants produced fruit in the ratoon crop than the plant crop. The increased number of plants producing fruit no doubt contributed greatly to the increase in yields per acre.

TRACE ELEMENT AND SOIL FUMIGATION TRIAL (KARAMAINI ESTATE, THIKA)

The trial was commenced on 11th April, 1953, and was designed to study the influence of copper, manganese and soil fumigation on yields of pineapples growing on virgin soil. The layout was of two blocks each of six plots. One block was treated with the soil fumigant D.D., the other block being left untreated. The planting material consisted of fruit crowns which were planted in two-row beds at a spacing of 3 ft. between the beds and 1 ft. $\times$ 2 ft. between the plants, giving a plant population of approximately 17,000 per acre.

The soil fumigant was applied by a hand soil injector in a 10 per cent concentration with diesel oil ten days before planting took place and when moist soil conditions prevailed. The concentration was applied at the rate of 142 gal. per acre. Copper was used in three levels: 0, 0.25 per cent and 0.5 per cent concentrations. Manganese was used in two levels, 0 and 0.5 per cent. These two elements were first applied as foliage sprays six months after planting. Three applications of each were made at monthly intervals.

A standard application of sulphate of ammonia was made in two dressings, to the whole trial, at the rate of 6 lb. per 100 plants or 1,020 lb. per acre. The first application was made two months after planting and the second application was made four months later. The period from planting to first harvest was 21 months. The total period taken to produce the plant crop was 31 months. Table VII shows yield results.

Table VII.—Mean Yields and Number of Pineapples per acre, average fruit weight and the percentage of fruit of 4 lb. and over

Treatment	BLOCK I				BLOCK II			
	Fumigated				Not Fumigated			
	Tons per acre	No. fruit per acre	Mean weight per fruit	% fruit of 4 lb. and over	Tons per acre	No. fruit per acre	Mean weight per fruit	% fruit of 4 lb. and over
(1)			lb.				lb.	
Cu 0.25% ..	24.9	14,960	3.73	52.0	26.5	14,620	4.04	69.0
Cu 0.25% ..	27.4	16,320	3.86	66.0	25.9	14,620	3.97	44.0
Cu 0.5% ..	20.1	12,900	3.77	34.0	18.7	11,220	3.73	39.0
Mn 0.5% ..	23.1	14,280	3.62	21.0	29.7	16,320	4.07	70.0
Cu 0.25% Mn ..	26.7	16,320	3.67	29.0	32.1	14,040	4.06	82.0
Cu 0.5% Mn ..	18.7	13,600	3.09	10.0	25.9	14,280	4.07	67.0

As the treatments in this trial have been completely confounded with Block I plus D.D. and Block II minus D.D., significant block differences shown in the above table might be due to the presence or otherwise of the D.D. soil fumigant or the natural soil differences, aspect differences, or any different factors which influenced the crop itself in the blocks. It has not been statistically possible to determine whether any yield differences found between blocks are in effect D.D. treatment differences.

Copper at 0.5 per cent shows a depressing effect on both yields per acre and mean fruit weight. Treatment differences are significant: copper at 0.5 per cent having reduced the number of fruit per acre. (Sig. $P = 0.05$ only.) The average fruit weight differences between blocks is also significant. Soil fumigation with D.D., has reduced fruit weight by 0.46 lb. per fruit. (Sig. at $P = 0.05$ only.)

Conclusion.—Though it has been statistically impossible to determine the influence of the soil fumigant, D.D. on yields, it is almost safe to assume that D.D. is likely to be of little economic importance on virgin soils for the purpose of growth stimulation. Since the total area of the trial covered 300 sq. yds., it is unlikely that there were any great differences in the soil or aspect which were likely to exert any greater influence than the D.D. Not only may D.D. be responsible for the reduction in mean fruit weight, but also for the reduction in the number of fruit of 4 lb. and over as may be seen in Table VII. On a block basis, Block I plus D.D. and Block II minus D.D. show that the percentage of fruit of 4 lb. and over were 35 per cent and 61 per cent respectively.

SPACING AND MULCH TRIAL (KARAMAINI ESTATE, THIKA)

This trial was commenced in May, 1953, and was composed of two replicated blocks to compare three different spacings with and without mulch. The plot size was composed of 300 plants throughout and the planting material consisted of fruit crowns which were planted on virgin murrum-type soil. A standard dressing of sulphate of ammonia at the rate of 6 lb. per 100 plants was applied in two dressings of 3 lb. per 100 plants. The first application was made two months after planting and the second application six months after planting.

The three spacings used in the trial and the approximate number of plants per acre were:—

(a) two-row beds at 1 ft. $\times$ 2 ft. $\times$ 3 ft. = 17,000 per acre.

(b) three-row beds at 1 ft. $\times$ 2 ft. $\times$ 7 ft. = 12,000 per acre.

(c) three-row beds at 1 ft. $\times$ 2 ft. $\times$ 9 ft. = 10,000 per acre.

The mulch was applied once immediately after planting between the rows only and to a depth of 4 in. The material consisted of old dried-up pineapple plants.

Though there was no difference in the sulphate of ammonia application per plant, the amounts per acre varied in accordance with the plant population. The respective applications for the three spacings were at the rate of 1,020 lb., 720 lb. and 600 lb. per acre.

Table VIII.—Mean Yields and Number of Pineapples per acre and average weight of Pineapples. (Means of two plots)

Treatments	MULCH				No MULCH			
	Yield per acre	No. of fruit per acre	Mean weight per fruit	% of fruit of 4 lb. and over	Yield per acre	No. of fruit per acre	Mean weight per fruit	% of fruit of 4 lb. and over
	<i>tons</i>		<i>lb.</i>		<i>tons</i>		<i>lb.</i>	
1 ft. $\times$ 2 ft. $\times$ 3 ft.	23.7	12,712	3.81	40.0	27.2	13,720	4.42	60.0
1 ft. $\times$ 2 ft. $\times$ 7 ft.	19.8	9,440	4.54	61.0	22.9	10,160	4.55	61.0
1 ft. $\times$ 2 ft. $\times$ 9 ft.	15.7	8,019	4.62	58.0	14.1	7,705	4.20	50.0

As may be expected, spacing has very significantly affected the yields per acre on account of the higher plant population per acre which results from the closer spacings. The different spacings, however, have not significantly affected the average fruit weight. Mulch has not significantly affected yields, but there is a very slight tendency for it to produce lower yields than the unmulched treatments.

Mulch appears to have reduced the number of fruit of 4 lb. and over in the closer spacing of 1 ft. $\times$ 2 ft. $\times$ 3 ft. though there is no significant difference in the two wider spacings as a result of the treatments.

Summary.—Spacing has very significantly affected yields of pineapples and the number of fruit harvested per acre. Spacing has not, however, significantly altered the average fruit weight. The 1 ft. $\times$ 2 ft. $\times$ 3 ft. spacing in two-row beds is a far more productive spacing in terms of yields per acre than the old standard spacing of 1 ft. $\times$ 2 ft. $\times$ 9 ft. in three-row beds.

Mulch does not appear to have any beneficial influence whatever.

ROTATION TRIAL (COFFEE RESEARCH STATION, RUIRU)

This trial has now produced the plant crop. The object of the trial, in the first cycle, was to see if pineapples would successfully follow Napier grass.

The trial was planted in April, 1953 and was composed of a $1\frac{1}{2}$ -acre block. The planting material was of crowns and suckers; one acre being composed of crowns. The plant spacing was in two-row beds at 1 ft. $\times$ 2 ft. $\times$ 3 ft.

Establishment of the plants was slow, and in time it was observed that there were numerous large pockets of poorly coloured, suppressed plants. The area affected represented about one-third of the total area planted. Since few of the plants made good growth it was decided to apply sulphate of ammonia. The first application, at the rate of 500 lb. per acre, was made one year after planting. Four applications were made bringing the level up to 2,000 lb. per acre. Though response was noted on the better plants, very little response was observed on the poorer plants.

As fruiting of the plant crop was irregular and prolonged and likely to overlap with the first ratoon crop, it was decided to conclude the harvest of the plant crop in November, 1955. The period from planting to the final harvest was therefore 32 months. The plant crop yield result was 3.7 tons per acre with a mean fruit weight of 1.48 lb.

The results produced from the trial indicate that it would be most unwise until further information is available to plant pineapples on land just cleared of Napier grass.

Berry Fruits

YOUNGBERRY

The yield of youngberries (planted 1952) at Molo during 1955 was at the rate of 6,216 lb. per acre. This fruit is now considered as proved for Mo'o and similar climates and commercial planting is recommended. Plots established at Kitale and Ruiru have proved unsuccessful because the plants do not receive sufficient winter chilling in these climates. Investigations into the market prospects of the crop reveal that it is very popular on the local market as a fresh fruit, and sells readily at a wholesale price of Sh. 2 per lb. Attempts to rail the fruit from Molo to Nairboi have not so far proved successful, but fruit transported by car arrives at Nairobi in good condition. Canning samples produced at Molo and by Kabazi Cannery Ltd. show that the canned product is of high quality. A canned sample submitted to the Colonial Products Laboratory, England, for a market report was favourably reported on for quality, but the prospects for selling more than a small quantity of canned youngberries in England were regarded as unfavourable. The fruit is comparatively unknown in England and consumer preference is for the berry fruits which are well established there. Investigation of other potential overseas markets is in progress. When sufficient fruit is available for canning, the canned product will be placed on the East African market in the first place.

BLACKBERRY

Of the three blackberries imported as seed from South America, the Shanks blackberry (*Rubus Shankii*) has proved so far to be the most suitable for commercial production. Yields have not yet been recorded but it is estimated to be a heavier yielder than the youngberry. The fruit is large, up to 1 in. diameter, and black, it is somewhat too acid for eating as a fresh fruit, but is excellent stewed. Canning samples produced at Molo show that the fruit is very suitable for canning. The canned product is dark red and has a typical blackberry flavour.

The Mora de Castilla (*Rubus glaucus*) is a bright red blackberry of very attractive appearance. The fresh fruit has a distinctive flavour, rather similar to the mulberry. Samples canned at Molo show that the fruit has disadvantages for canning. The colour fades badly after processing, which would make the addition of artificial colour necessary, and the fruit is inclined to break up in the can. This fruit should, however, prove very suitable for home growing and consumption.

The Honduran blackberry (*Rubus Honduriensis*) is a prolific bearer of black, rather elongated and very acid fruit. When canned, the fruit has no distinctive flavour, and it is not considered suitable for commercial canning. Owing to its extremely vigorous and upright growth, the plant is likely to prove of value for hedging, particularly in African areas, but trial of its vigour in different climates will have to be made before it can be recommended for this purpose.

None of the three blackberries described above appear to have any dormant period at Molo, they are likely, therefore, to have a considerably wider climatic range in Kenya than the youngberry. Trials in a number of climates are to be carried out.

Vegetables

At Ruiru an irrigated versus unirrigated vegetable trial was commenced on the long rains. The object of the trial was to determine yields with and without irrigation during the rainy season. The trial was commenced on 4th March, 1955, and was concluded on 10th November, 1955. The layout was of four randomized blocks each of seven plots. This was duplicated to enable comparisons between the irrigated and unirrigated treatments. The plot size was 144 sq. ft. The manurial treatment consisted of 10 tons of *boma* manure per acre and double superphosphate at the rate of 300 lb. per acre. Sowing was direct in the case of beet, lettuce, carrots and onions, while cabbage, broccoli and leeks were sown in nursery beds for transplanting later. The leeks failed to germinate and could not be included in the trial. Rainfall and irrigation amounts varied according to the kind of crop, but details can be seen in Table IX.

The yield results show the futility of attempting to grow vegetables commercially without irrigation facilities. Though the sowings coincided with the long rains season, the rains were light and distribution poor for vegetable crops. The 13.76 in. rainfall figure given in Table IX represented the rainfall amount recorded during the trial period. The April and May rainfall was sufficient to establish the sowing, but the rainfall amounts during June, July and August was only 0.48, 0.11 and 1.58 in. respectively. Consequently, the unirrigated crops either shrivelled up or became stunted and worthless. The broccoli yield was poor, but this was attributed to variety unsuitability and a disease, believed to result from molybdenum deficiency, which caused an acute narrowing of the leaves.

Table IX

Crop	Spacing	IRRIGATED				UNIRRIGATED		
		Mean weight per root/head	Yield per acre	Irrigation amount	Rainfall amount	Mean weight per root/head	Yield per acre	Rainfall amount
		lb./oz.	tons	inches	inches	lb./oz.	tons	inches
Cabbage ..	2' x 2'	3.5 lb.	9.5	15.0	10.48	1.2 lb.	0.21	13.76
Broccoli ..	2' x 2'	3.0 lb.	3.6	22.5	13.76	Nil	Nil	13.76
Lettuce ..	1' x 6"	8.2 oz.	7.8	17.5	9.87	Nil	Nil	9.87
Carrot ..	1' x 3"	5.4 oz.	10.4	17.5	9.98	1.2 oz.	0.28	13.76
Beet ..	18" x 6"	10.6 oz.	7.4	15.0	10.48	7.9 oz.	0.32	10.48
Onion ..	1' x 6"	6.2 oz.	10.7	17.5	13.76	0.95 oz.	0.07	13.76

Lima Bean.—A variety trial of ten bush types was sown at Ruiru on 15th April, 1955, during the long rains and was concluded on 2nd August, 1955. The varieties had been grown unsuccessfully during the short rains of 1953. Failure was then attributed to poor soil conditions. The layout consisted of four

randomized blocks each of ten plots. Spacing was 3 ft. between the rows and 1 ft. between the plants. The manurial treatment consisted of 10 tons of *boma* manure and 300 lb. of double superphosphate per acre. The rainfall during the trial period was 12.55 in. Yield results were as follows:—

Table X

Varieties	Yields per acre	Varieties	Yields per acre
	<i>lb.</i>		<i>lb.</i>
Okla. 13 cordner	3,565	US. 252 NRB	3,018
Ex. Thorogr 524. . . .	5,021	US. 851 NRB	3,606
Clarks Bush	3,292	US. 153 DMRWC	3,527
Lima Green	4,755	US. 951 NRB	3,356
U.S. 151 NRB	3,168	Utah 16-2	2,879

The above yields are based on pod weight, the pods being harvested when 3-5 per cent showed signs of becoming shrivelled. The yield results of this trial are far superior to those obtained from the 1953 trial which produced yields ranging from 28 lb. to 843 lb. per acre. It is possible that yields could be further increased by a closer planting. The distance between plants was considered satisfactory, but 18 in. between the rows instead of 3 ft. would have been a better spacing. Not more than half the inter-row space was covered by the plants. It is possible that the increased yield obtained in this trial may be due in part to the use of acclimatized seed.

CAULIFLOWER

A trial was carried out at Molo to compare the Mauritius variety of cauliflower, seed of which was obtained from Mauritius, with two other varieties which are commonly grown locally, Phenomenal Early and Early Snowball. Seed was sown on 26th June, two plots of 100 plants of each variety were planted out on 19th August, 1955, at a spacing of 2 ft. $\times$ 1½ ft. There was no marked difference in the growth rate of the three varieties. Yield as the mean of two plots, are given in the table below:—

Table XI

Variety	Yield lb. per acre	Harvest started	Harvest completed
Early Snowball	4,929	9-11-55	13-12-55
Mauritius	6,651	"	"
Phenomenal Early	9,806	21-11-55	"

It is considered that the Mauritius variety would probably produce a heavier yield in a warmer climate than Molo. The low yield of Early Snowball is partly accounted for by the tendency of this variety to bolt when planted out during the cool seasons.

Tomatoes

Preliminary results of seven tomato variety trials, six of which were in Rift Valley Province and one in Nyanza, were given in the Annual Report for 1954. Each trial contained 10 varieties and the main object was to find the most suitable varieties for the manufacture of tomato puree for export. Other objects were to find whether Californian methods of producing canning tomatoes could be applied to local conditions, to assess the suitability of different areas for the production of canning tomatoes and the value of irrigation.

As previously reported, the trials proved that the Californian system of production, direct sowing, no staking or pruning and wide row spacings, was successful under our conditions. The spacing of plants in the row should, however, be reduced from 3 ft. to 1½-2 ft. Irrigation was proved to be a necessity in an average season, all those trials or parts of trials which were unirrigated having been a complete or partial failure. The Hoey's Bridge district of the Trans Nzoia was judged to be the most suitable area for the production of canning tomatoes. Final yield results of the trials which were considered to be worth recording are given in the table below:—

Table XII.—Tomato variety Trials—Tons/acre

Variety	1 Barret's Farm	2 Irwin's Farm	Un- irrigated	3 Arnold's Suam Valley		4 Hort. Station
	Nakuru Irrigated	Hoey's Bridge Irrigated		Irrigated	Un- irrigated	Kitale Irrigated
T x 28 A	3·81	7·18	Not recorded	10·69	7·27	12·59
Tatinter	4·81	9·80		14·85	8·07	13·24
K.Y.I.	5·64	6·16		17·54	9·54	12·96
Bawley's Selection	4·88	14·85		15·35	14·71	14·72
San Marzano ..	4·625			13·04	12·68	11·12
Genovese	6·82	11·52		16·96	11·91	15·82
Break O'Day ..	4·31	14·18				
Early Red	6·325	10·62		15·32	11·58	11·39
Early Baltimore ..	5·71	18·71		17·79	10·25	
Homestead	5·37	16·81		9·69	11·56	
Strain VIII		19·70				17·69
Strain VII				17·55	11·75	16·10
Strain VI						9·45

Sowing dates and period of harvest were as follows:—

Table XIII

Trial	Sowing Date	Harvest Started	Harvest Completed
1. Barret's Farm, Nakuru ..	6-8-54	8-12-54	18-1-55
2. Irwin's Farm, Hoey's Bridge ..	19/20-8-54	9-12-54	21-3-55
3. Arnold's Farm, Suam Valley ..	18-8-54	15-12-54	1-4-55
4. Hort. Station, Kitale	17-8-54	4-12-54	7-4-55

The short harvest period at Barret's farm was due to an attack of blight, *Phytophthora infestans*, which also seriously reduced the yield, as can be seen by reference to the yield table. The following table shows the results of tests carried out in the field with a refractometer, for soluble solids content of the fruit. As it was difficult to find enough sufficiently ripe fruit for the purpose, the figures may be assumed to be somewhat lower than could be expected.

Table XIV

Soluble Solids, per cent

Variety	Trial 2	Trial 3	Variety	Trial 2	Trial 3
T x 28 A	3	4	Genovese	6	6
Break O'Day	5	—	Strain VII	—	6
K.Y.1.	4	—	Early Baltimore	5	3
Bawley's Selection	5	6	Homestead	6	7
San Marzano	—	5	Early Red	4	6
Tatinter	—	—	Strain VIII	8	—

A study of the harvest records of trials 2 and 3 reveals the cropping pattern of tomatoes in the Trans Nzoia district. Harvesting started on 16th December, approximately 120 days after sowing. The peak harvest period started about 30th December, or 134 days from sowing, and continued until 27th January, or 162 days from sowing. The percentage of the total crop harvested from the eight varieties which were represented in both trials, during this 28-day peak period, varied between 60 per cent for Homestead and Genovese, to 77 per cent for Bawley's Selection. These figures are calculated on the mean percentage for the two trials. The varieties fall into three types of cropping pattern; early varieties, an example of which is K.Y.1., where the mean peak occurs in the early part of the 28-day period; late varieties, such as Bawley's Selection, with the main peak in the latter part of the 28-day period; the third type has no extreme peak period, the crop being well spread out, an example is Genovese.

For the production of canning tomatoes in the Trans Nzoia, the sowing season is probably not longer than three weeks, 18th August to 7th September. Earlier sowings are likely to receive too much rain during the first part of the growing season, whilst sowing after 7th September will run the end of the crop into the "long rains" period. A tomato cannery, therefore, would have to be designed to accept from 60 per cent to 75 per cent (depending on the varieties grown), of the total seasons crop, within a peak period of seven weeks, say from 30th December, to 17th February.

The average yields of tomatoes which can be expected, cannot be based on results of one season's trials. The greatest factor in seasonal variation of yields is the incidence of blight, *P. infestans*, which again depends on variations in rainfall and to a certain extent temperature. In these trials no spraying against blight was attempted. The great cost of such spraying, and the rather ineffective control of the disease thus obtained in an inclement season, is described in the account of the Ruiru trials which follows.

TOMATO TRIALS AT RUIRU

Trial I.—This trial was designed to compare tomato yields from single plots consisting of 96 plants per plot when grown under similar cultural methods to those practised in Italy. Manurial treatments consisted of 50 tons of *boma* manure per acre and 1,000 lb. of N.P.K. fertilizer per acre. Six varieties were grown at a spacing of 5 ft. $\times$ 2½ ft., the plants being unstaked and unpruned. The seeds were sown in nursery beds and when large enough to handle easily were transplanted

to a distance of 3 in. $\times$ 3 in. On reaching a height of 6 in. they were transplanted to the field. The varieties and yield results were as follows:—

Table XV.—Yields (marketable fruits only)

Varieties	Yield per acre	No. fruit per lb.	Yield per plant
	<i>tons</i>		<i>lb.</i>
San Marzano	6.5	11.3	3.9
T $\times$ 28A 9:1:3	12.7	3.0	7.6
Bawley's Selection	13.6	4.7	8.1
Amateur	9.2	7.1	5.8
K.Y.1	18.7	3.4	11.1
Tatinter	11.6	3.6	6.9

First harvests were made on 2nd July, 1955, or four months after sowing. The final harvest was made on 19th September, 1955, or just over six months from sowing. The rainfall amount during the trial period was 13.96 in. and the irrigation amount was at the rate of 13.3 in. per acre.

The *boma* manure cost Sh. 40 per ton or Sh. 2,000 per acre. The fertilizer costs were Sh. 279 per acre while the fungicide cost Sh. 240 per acre. A total outlay of Sh. 2,519 excluding labour, had therefore to be covered before profit could start to accumulate. At a possible canning price of 10 cents per lb. or Sh. 224 per ton, yields would have to be considerably over the 10 ton per acre level if worthwhile profits to the grower are to be achieved. That is, of course, where tomatoes are to be grown under similar conditions to those which prevailed during this particular trial. A heavy loss of crop resulted in this trial due mainly to late blight. Sun scorch and birds accounted for a very small percentage of the loss. The mean loss over all the six varieties was at the rate of 7.7 lb. per plant or 12.1 tons per acre. The spacing of 5 ft. $\times$ 2½ ft. appeared satisfactory as all the varieties except Amateur easily covered the area. Amateur proved to be a very small, compact, true bush type which could have been planted at a much closer spacing. Under field conditions, therefore, this variety, when more closely spaced could be expected, as a result of the increased plant population, to produce a much heavier yield than was recorded in the trial. San Marzano yields were surprisingly low in this trial. The plants however, became most vigorous and rampant and an almost impenetrable mass of growth developed at the expense of fruits. From the performance of previous trials it would appear that the manurial treatment of the trial was excessive for San Marzano which resulted in vegetative growth rather than fruit production. The other varieties did not show any evidence of excessive vegetative growth.

Trial II.—This was a duplicated trial to enable a study of irrigated versus unirrigated yields. The layout was a 5 $\times$ 5 latin square. The number of varieties grown was 5 and the number of plants per plot was 18. Plants were grown as bush types with no staking or pruning being carried out. *Boma* manure at the rate of 10 tons per acre and N.P.K. at the rate of 1,000 lbs. per acre was applied. Nursery treatment was the same as for trial I, the seedlings were transplanted to the field at a 4 ft. $\times$ 4 ft. spacing. The varieties and yields were as follows:—

Table XVI

Varieties	IRRIGATED			UNIRRIGATED		
	Yield per acre	No. fruit per lb.	Yield per plant	Yield per acre	No. fruit per lb.	Yield per plant
	<i>tons</i>		<i>lb.</i>	<i>tons</i>		<i>lb.</i>
Hundredfold	5.4	7.7	4.5	2.9	9.0	2.4
Argentine	5.1	4.9	4.2	2.8	4.2	2.3
Strain VII. . . .	5.2	10.6	4.3	3.3	10.0	2.7
Strain VIII	5.4	6.3	4.5	3.3	7.6	2.7
Strain X	6.0	7.3	5.0	2.4	10.0	2.0

Though yields are poor, there is no doubt that irrigation is vital to tomato culture even during the long rains season. The soil on which the trial was grown was situated on bench terraces and had not previously received bulk organic manuring. On such soils, it is evident that heavier manuring is necessary if high yields are to be achieved. Rainfall over the trial period was 13.96 inches and the irrigation amount was at the rate of 13.3 in. per acre. The irrigation frequency depended upon the interval between precipitations. In the early period, before the plants attained maturity and ground coverage, irrigations were required once weekly and once every 10 days when plant ground cover was complete. The first harvest was made four months after the seed was sown and the final harvest was made on the 19th September, 1955 for irrigated plants and on the 25th August, 1955, for the unirrigated plants or just over and just under six months for the trial periods respectively.

The loss in yields from both trials was enormous as a result of late blight, birds and sun scorch. Control measures against late blight were continuous from the time the seedlings were transplanted in the nursery until the plants showed decline as a result of exhaustion. Even under constant spraying, at intervals of 6-10 days, blight became evident on the variety Tatinter on 28th July, 1955 or shortly after the first harvesting. Blight might have been minimized during these trials had the irrigation frequency been reduced when the plants had reached the stage when ground cover was complete. The final irrigation was made on the 27th July, 1955 and the plants did not show moisture stress between then and the final harvest. Rain, however, did fall during August totalling 1.58 in. and this was undoubtedly beneficial. The results of these trials, as in the case of previous trials grown during the long rains season, do show that for commercial culture it would be unwise to grow tomatoes under similar climatic conditions to those at this station during the long rains. If crops are to be assured, irrigation, and hot dry weather for growth of the plants and ripening of the crop are essential.

Peas

A trial of 10 varieties of canning peas was carried out at Molo with the object of assessing yield and canning quality under local conditions. The layout consisted of single plots of the following varieties: Clipper, Foremost, Kelvedon Wonder, Thomas Laxton, Laxton's Superb, Fillbasket, Onward, Alderman, Unica, and Mansholt's Pluk. Seed was sown in drills 7 in. apart between 6th and 12th of August. In spite of seed dressing with an organo-mercurial compound losses from pre-emergence damping off were extremely heavy. Much seed was washed out of the ground through very heavy rain just after sowing. Losses of seedlings also occurred through hail, which fell on several occasions. These factors combined to cause a very poor stand of plants, with the exception of the

variety Unica which was very good. The stand of Unica was so dense that weed growth was suppressed and no weeding of this plot was necessary. Unica ripens very evenly and it was decided to put the whole plants through a vining machine as an experiment, instead of hand picking the crop, which is the usual method of harvesting canning peas in Kenya. The crops was pulled on 17th November, transported to Kabazi Cannors Ltd., put through their vining machine and the peas canned at once. The yield from a plot of about $\frac{1}{6}$ acre, was at the rate of 7,000 lbs. per acre, which by comparison with the average yield of canning peas, is exceptionally good. Yields of the remaining nine varieties in the trial were not recorded owing to the poor stand of plants, but sufficient was harvested from each to carry out a canning test, the remainder was harvested as seed.

On the East African market, the canned pack of Unica would be readily saleable but on the United Kingdom market, which is at present highly competitive for canned peas, considerable improvement would be required. Samples were sent to the Colonial Products Laboratory and to the Canning Research Station at Chipping Campden for examination and market report. The comments received from these two authorities and from members of the trade, were not entirely unfavourable but they have pointed out a number of defects which will receive attention in any future packs of Unica produced here. A report on canned samples of the remaining nine varieties is not yet available.

Acknowledgment

In conclusion I wish to thank the staff of the Horticultural Section for the work carried out during the year. Officers have often worked under considerable pressure to complete the volume of work required. I would also like to thank officers of other sections for their valuable co-operation, in particular Mr. J. B. D. Robinson (Soil Chemist, Coffee Services), for the statistical interpretation.

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Senior Horticultural Officer,

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (PYRETHRUM), 1955

Meteorological

Detailed meteorological records for the various pyrethrum stations will be found in the Appendix to this Report.

The rains started on a promising scale on April 10th but were erratic and scanty in May and June and no appreciable amounts were recorded again until July 17th. Established trials and plots received a good impetus through the early April rains and yielded a few fairly heavy pickings after which, however, they were not able to sustain the pace owing to lack of water, with the result that plants suffered severely. When heavy rains fell eventually from the middle of July to the end of September it took them some time to recover, especially as little sunshine prevailed during this period. Therefore flower yields did not improve on most stations until October or November, while on the other hand the fungus *Ramularia bellunensis* had spread during the cool and sunless weather of August and September. A dry period set in abruptly with October and by December it appeared as if only the 1955 plantings would still produce any appreciable quantity of flowers. Unexpected and rather heavy rains started in the middle of December which will certainly prolong the picking of this season's plantings and might even have a certain beneficial effect on older plantings. The total rainfall for the year came up to average, in fact certain areas had more than their quota, but the distribution was unsatisfactory. In spite of this, the total flower deliveries amounted to 5,998,784 lb., 1,376,940 lb. more than in 1954. This reflects the effect of favourable flowering conditions at the end of 1954, an expansion of the pyrethrum acreage, better cultivation methods and possibly the wider use of improved varieties. The average pyrethrin content for the Colony was 1.53 per cent.

Experimental Work

(Trials reported in this Section's Annual Report for 1954 and not included in the current Report have either been concluded or discontinued.)

PHOSPHATE/RIDGING TRIALS

In 1954 trials were planted at Londiani, Ainabkoi, Kipkabus, Eldoret and on the Kinangop. To these were added three more experiments in 1955 at Dundori, Nanyuki and Mweiga. This last suffered so severely from drought conditions in June and July that it had to be abandoned. The results over two seasons up to date for some of the trials planted in 1954 are as below (yields in lb./acre dry flowers):—

Treatments	Ainabkoi	Kipkabus	Londiani	Kinangop
A. on flat, no phosphate	447	245	264	1,546
B. on flat, 300 lb./acre Triple Supers. in plant. holes	604	412	700	1,744
C. on ridge, 300 lb./acre Triple Supers. in plant. holes	591	387	470	—
D. on ridge, 300 lb./acre Triple Supers. at base of ridge	513	415	617	2,097
E. on ridge, 100 lb./acre Triple Supers. in plant. holes, 200 lb. at base of ridge	694	318	625	—
F. on ridge, no phosphate	498	333	174	1,678
G. on flat, 750 lb./acre Soda Phos- phate in plant. holes	448	346	275	1,682
H. on ridge, 750 lb./acre Soda Phos- phate at base of ridge	488	465	421	1,948
Average effect of Triple Supers. ..	+128**	+94*	+384***	+309
Average effect of Soda Phosphate ..	—5	+117*	+129	+204
Average effect of ridge planting ..	+57	+49	+48	+251

*Significant at $P=0.05$

**Significant at $P=0.01$

***Significant at $P=0.001$

These yield figures provide interesting food for thought. The heaviest crops have been harvested on the Kinangop which for reasons of climate and soil offers the most favourable growing conditions for pyrethrum. Yields within the other three trials are only moderate, partly because growth in the first (1954/55) season had been exceptionally slow. The effect of Triple Superphosphate has been most pronounced on reddish soil at Londiani which also gave the poorest chemical analysis. All soils that responded to phosphatic dressing show a low base exchange capacity (i.e. a saturation of less than 60 per cent). It would appear that applications of phosphates on soil types with a saturation of 70 per cent or more are without effect. Ridging has resulted in a yield increase in all cases; this is an unusual experience and may well be due to the over-abundant rainfall in August and September, 1955. As the experiments will be continued in 1956 it will be seen whether the effect is purely a seasonal one. Planting on ridges holds, however, certain mechanical advantages as well, and can, as a general rule, be recommended. The fact that only a few of the yield differences are of statistical significance is most likely due to the inefficient design of the trials which are being followed up in several cases by experiments of a more elaborate nature.

Of the trials laid down in 1955, the most outstanding results were recorded on Mr. H. R. Munro's farm at Dundori, on reddish forest glade soil:—

Treatments	Yield lb./acre dry flowers
A. on flat, no phosphate	42
B. on flat, 300 lb./acre Triple Supers. in plant. holes ..	204
C. on ridge, 300 lb./acre Triple Supers. in plant. holes ..	279
D. on ridge, 300 lb./acre Triple Supers. at base of ridge ..	279
E. on ridge, 100 lb./acre Triple Supers. in plant. holes, 200 lb. at base of ridge	303
F. on ridge, no phosphate	46
G. on flat, 750 lb./acre Soda Phosphate in plant. holes ..	98
H. on ridge, 750 lb./acre Soda Phosphate at base of ridge	167
Average effect of Triple Supers.	+222*** (significant at $P=0.001$)
Average effect of Soda Phosphate	+89** (significant at $P=0.01$)
Average effect of Ridging	+100** (significant at $P=0.01$)

The trials indicate that most likely a far larger range of soils would give an economic response to phosphatic fertilizers than was evident from results of the first manurial experiments laid down in 1945 and 1946. This opens possibilities for an increase in flower production over the existing acreage in many areas. Unfortunately, it does not necessarily follow that pyrethrum will react to phosphate dressing just because cereals respond on some particular soil type.

STRIPPING TRIALS

Stripping down to flowers with horizontal petals—the method now generally employed on farms—is being compared with stripping down to and including flowers with vertical petals and down to buds respectively at different intervals. The first season, 1954/55, yielded the following results (lb. pyrethrins per acre):—

	Petals horizontal	Petals vertical	Buds	Average Time
2 weeks	18.13	17.55	9.88	15.19
3 weeks	14.36	14.25	10.00	12.87
4 weeks	16.98	16.29	14.88	16.05
6 weeks	13.23	11.86	12.63	12.57
Average Stripping	15.67	14.99	11.85	

Significant treatment differences for (a) stripping methods:—

	P=0.01	P=0.05
	2.23	1.65
(b) Stripping × time:		
	P=0.01	P=0.05
	4.47	3.30

In the second, 1955/56, season results in lb. pyrethrins per acre were as below:—

			Petals horizontal	Petals vertical	Buds	Average Time
2 weeks	..	..	24.34	20.88	14.44	19.89
3 weeks	..	..	24.66	22.71	16.82	21.40
4 weeks	..	..	20.88	21.13	18.46	20.16
6 weeks	..	..	18.61	19.15	21.83	19.86
Average Stripping	..		22.12	20.97	17.89	

Significant treatment differences for (a) stripping methods:—

	P=0.01	P=0.05
	1.14	0.84
(b) Stripping × time:		
	P=0.01	P=0.05
	2.29	1.69

Again, stripping down to buds had a detrimental effect on the yields of pyrethrins and while in the foregoing season no significant difference was found between stripping to flowers with horizontal and vertical petals respectively, this time the difference was very marked at the 2 and 3 weekly intervals. The absolutely highest yields were recorded by stripping down to petals horizontal at intervals of 2 and 3 weeks, not quite in conformity with the first season's findings. It would be inadvisable at this stage to advocate the use of any mechanical picker which does not possess a certain degree of selectivity.

The physical analyses of the individual picking samples yielded figures similar to those recorded in 1954/55: in the samples for 2 weekly stripping down to buds very few flowers with open petals occurred, while the percentage of those with vertical petals varied between 17–40 per cent and buds contributed 47–77 per cent; the equivalent sample taken at 3-weekly intervals contained from 5–47 per cent mature flowers, 14–35 per cent flowers with vertical petals and only from 20–65 per cent buds, the yields of pyrethrins are slightly higher than in the 2-weekly sample but still considerably lower than in the normal stripping treatment. The proportion of mature flowers in stripping down to petals horizontal at 2- and 3-weekly intervals varies from 50–80 per cent approximately. Stripping down to buds at 4- and 6-weekly intervals respectively results in a lower percentage of buds (14–50 per cent) than in the equivalent treatment at 2- or 3-weekly intervals, while the proportion of fully open and mature flowers is considerably higher (about 20–50 per cent) resulting in a more satisfactory yield of pyrethrins. On the other side of the picture, the percentage of overblown

flowers becomes so high in the samples for 6-weekly stripping to flowers with horizontal or vertical petals (14-20 per cent) that again a loss of pyrethrins occurs; the plant is subjected to a certain strain if these inflorescences are kept too long and regeneration of buds is impaired. This experiment will be continued for a third season. An identical trial has been laid down with clone 24 at Ol Joro Orok.

CUTTING BACK TRIALS

A small trial was planted at Molo to determine whether cutting back of the first flowers appearing a few weeks after planting encouraged the vegetative growth of the splits and subsequently their output of flowers. This was found not to be the case; although the difference was statistically not significant the uncut control plots yielded better than the cut back treatments. In the second, 1955/56 season, the yields were as follows:—

Treatment	Yield lb./acre dry flowers
Control	1,280
Once cut back	1,139
Twice cut back	1,174

The cutting back treatments carried out in the season of planting had, therefore, no cumulative effect, i.e. they did not increase yields in the second season.

Three similar trials were planted in 1955 on the Grassland Station, Molo, at Subukia and Ol Joro Orok. Cutting back of the first flowers, before picking commenced, was carried out repeatedly up to 4, 5 and 6 months respectively after planting. The trial on the Grassland Station, Molo, yielded the following results to date:—

Treatment	Yield lb./acre dry flowers
Control	661
Cut back up to 4 months	606
Cut back up to 5 months	399
Cut back up to 6 months	379

The other two experiments suffered in the early stages through drought conditions but all three trials will be continued for another season.

LARGE ROTATION TRIAL

The object of the trial is to determine the most suitable place for pyrethrum within a rotation. The following rotations are under test:—

- (1) Continuous Pyrethrum (replanted every third year).
- (2) Pyrethrum/Grass.
- (3) Pyrethrum/Cereals.
- (4) Pyrethrum/Grass/Grass.
- (5) Pyrethrum/Pyrethrum/Grass.
- (6) Pyrethrum/Cereals/Grass.

Each crop covers a period of three years. The continuous pyrethrum plots are sub-divided, one half receiving phosphates or compost, the second half remaining unfertilized. In order to be able to test each phase of every rotation at any one year, the large trial has been planted up in three complete groups, in 1947, 1948 and 1949 respectively. The grass plots, laid down with *Bromus marginatus* are grazed by sheep.

To date the experiment has given the following results: pyrethrum has not responded to manurial treatment. Plots bearing continuous pyrethrum or cereals have deteriorated in their soil structure more quickly than those under grass. This could be observed by the run-off taking place after a heavy shower. In spite of this, the pyrethrum yields within Rotation 1 showed no sign of declining until the 1953/54 season when drought conditions were rather more severe and certain plots seemed to suffer. During the 1954/55 season, only in a few cases continuous pyrethrum appeared to produce yields inferior to those of plots following a grass ley. By the end of 1955 the 1947 Group had completed its full 9-year cycle. It cannot be said that even after this period the yields of the continuous pyrethrum plots have declined. The small yield differences observed in 1953 and 1954 have not achieved statistical significance. Nevertheless, it would hardly be sound farming practice to carry on the cultivation of the crop without rotating it with cereals, fodder crops and grass; certain pests, as eelworm, and diseases could be controlled only in this manner. It may be found useful also to cash in on the fertility accumulated under pyrethrum by exploiting this with other crops. Wheat yields in the trial during the first two seasons following pyrethrum have been encouraging, but in practice it would probably be a sounder policy to substitute oats for wheat in the third year and to undersow these with grass. As a whole, the experiment which involved a great deal of work and expense has given disappointing results. This may be due in part to siting on ground with a great variation in soil, old ant hills, etc., but not altogether. It is not intended to continue with this trial.

Plant Breeding

Although the prospects for biological assays were by no means brighter than in the previous years, 305 new single plant selections were made on the various Experiment Stations, mainly amongst hybrids (crosses) and Dalmatian seedlings. Altogether 456 selected clones were under observation. 43 of the single plant selections under test from 1952-1954 were found sufficiently promising to be bulked up. The total number of clones which have been tested and multiplied and are available for either the crossing programme or for direct issue, is now 298. 20 crosses (hybrids) were made in an equal number of isolated plots at the various stations and 6 new isolated plots were established for the extension of the "sugar beet" breeding system at Mo'lo and Subukia.

A number of new hybrids and some of their parent clones were tested in 20 yield trials planted up under different conditions distributed over most of the pyrethrum-growing areas. Apart from C.43, C.51 and C.79, which continue to give a good performance over a wide range of the country, the following hybrids show promise: C.60, C.92, O.1, O.4, M.9, M.15, M.16 and M.20. Their parent clones are being bulked up in readiness for seed issue should they give further proof of their quality.

Botanical studies of the pyrethrum plant, chiefly on the problems of pollination and seed setting, continued. It is fairly evident by now that selfing occurs only in rare instances and that cross-pollination is essential for the production of viable seed. Even so, the percentage of fully developed seeds in a given sample is low and no definite answer can be given at the moment

to this rather exasperating problem. It may be that the number of pollinating insects attracted to the pyrethrum flowers is not sufficient for a more complete seed setting. Some trials were carried out with hormone sprays (α -naphthylacetic acid and β -indolylacetic acid) on a few seed production plots to test their effect, if any, on seed development. Experiments with inter-specific crossing and colchicine treatment to induce polyploidy have so far given no results.

Bulk seed issues were made from a large number of tested, vigorous clones at Molo, Ol Joro Orok and Subukia. The seed production fields of C.43 and C.51 were greatly enlarged and planted out on the Molo station. As a result only comparatively little seed of these hybrids was available up to the end of the year, but such seed should be in ample supply during 1956 as the parent clones have made vigorous growth. A small seed plot for C.79 was established. As the water supply on the Molo station is limited 14 clones were multiplied on Mr. Culwick's farm, Londiani, where sufficient water for irrigation is available. This means that in 1957 seed production fields for C.60 and M.9 can be planted up and by 1958 such for M.15, M.16 and others if they have proved satisfactory in current yield trials. The losses incurred through mechanical seed cleaning are very high mainly because the percentage of undeveloped seeds in otherwise mature seed heads is considerable. From 1,003 lb. seed delivered to the Pyrethrum Board, only 614 lb. cleaned seed could be distributed to the growers.

Pests and Diseases

After the heavy rains and long sunless periods of August and September bud disease appeared to be quite common and by the end of the year the incidence in certain cases was fairly severe. This is an observation which has been made repeatedly in foregoing years and may have physiological reasons: it has, for instance, been found on the Experiment Stations that high yielding plants in particular may towards the end of the flowering season show a high percentage of dead buds some of which died off without being attacked by the fungus *Ramularia*, other fungi appearing as secondary infections. Within the breeding programme, clones and hybrids are selected for resistance to the *Ramularia* fungus disease at various altitude levels, but this is obviously a slow process, especially as no clones have been found yet which are completely immune and could be used for crossing or direct issue. It is generally observed and borne out by statistical calculations, however, that high yielding vigorous plants produce well in spite of being attacked by bud disease. The average bud disease rates in the single plant selections on the various stations were as follows:—

						1953/54	1954/55	1955/56
Molo	..	..	..	..	..	7.6	4.3	2.9
Ol Joro Orok	..	..	..	..	..	8.7	16.4	20.0
Grassland Station, Molo	..	..	..	..	..	0.6*	30.0	19.1
Subukia	..	..	..	..	..	6.0	11.4	2.6*

*First season plants only.

Publications

The Agricultural Officer (Pyrethrum) wrote a new edition of the pamphlet "The Cultivation of Pyrethrum in Kenya" and a paper on "Mechanization in Pyrethrum" for the International Conference on the Mechanization of Agriculture held in Entebbe.

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Finally the untiring assistance and ready co-operation of the staff of this Section, European and African, is gratefully acknowledged.

U. KROLL,
Agricultural Officer (Pyrethrum).

APPENDIX

METEOROLOGICAL DATA

Molo (altitude 8,300 ft.)

1955				Mean Temp. °F.	Rainfall	Sunshine
					<i>in.</i>	<i>hrs.</i>
January	..	..	..	57.4	0.87	289.2
February	..	..	..	58.1	1.43	208.2
March	..	..	..	58.5	1.03	259.9
April	..	..	..	57.7	3.98	210.4
May	..	..	..	56.5	2.56	275.3
June	..	..	..	55.7	2.70	160.0
July	..	..	..	56.3	3.67	220.7
August	..	..	..	54.6	12.02	111.1
September	..	..	..	55.1	8.11	128.0
October	..	..	..	56.3	2.72	230.8
November	..	..	..	56.8	1.38	201.1
December	..	..	..	56.7	5.52	240.9
				Mean 56.6	Total 45.99	2,535.6

Marindas (Grassland Station, altitude 9,200 ft.)

1955				Mean Temp °F.	Rainfall	Sunshine
					<i>in.</i>	<i>hrs.</i>
January	..	..	..	56.0	0.84	276.9
February	..	..	..	56.0	1.43	188.2
March	..	..	..	56.1	0.72	252.1
April	..	..	..	55.3	6.29	188.3
May	..	..	..	53.9	1.98	228.1
June	..	..	..	52.0	5.17	189.1
July	..	..	..	50.9	5.55	172.5
August	..	..	..	51.4	13.55	108.0
September	..	..	..	49.9	12.55	61.0
October	..	..	..	53.7	1.85	202.8
November	..	..	..	52.4	3.99	166.1
December	..	..	..	52.8	4.54	187.0
				Mean 53.4	Total 58.46	2,220.1

Subukia (altitude 7,000 ft.)

1955	Mean Temp. °F.	Rainfall	Sunshine
		<i>in.</i>	<i>hrs.</i>
January	62·5	0·18	275·2
February	63·8	2·99	288·8
March	65·3	0·05	266·0
April	60·7	4·62	201·4
May	60·7	4·35	219·7
June	60·4	3·16	208·3
July	59·9	5·85	208·2
August	60·3	10·07	207·5
September	59·2	6·31	177·9
October	59·9	2·47	226·3
November	60·4	2·25	199·0
December	61·9	2·77	239·1
	Mean 61·3	Total 45·07	2,717·4

Ol Joro Orok (altitude 7,800 ft.)

1955	Mean Temp. °F.	Rainfall	Sunshine
		<i>in.</i>	<i>hrs.</i>
January	56·7	0·25	275·6
February	63·2	1·19	210·6
March	58·4	0·23	268·3
April	57·4	4·70	210·6
May	55·9	3·10	216·1
June	55·0	2·02	214·1
July	54·4	3·75	188·5
August	55·2	7·28	149·0
September	55·0	7·36	163·0
October	57·0	0·99	229·9
November	56·8	2·06	186·6
December	57·7	2·38	214·2
	Mean 56·9	Total 35·31	2,526·5

ANNUAL REPORT OF THE OFFICER IN CHARGE SISAL RESEARCH STATION, THIKA, FOR 1955

Rainfall

			Average previous 14 years Inches
<i>Inches</i>			
January	..	..	1.06 in 3 days
February	..	..	3.37 in 9 days
March	..	..	0.80 in 7 days
April	..	..	6.12 in 12 days
May	..	..	3.59 in 11 days
June	..	..	0.13 in 3 days
July	..	..	1.49 in 4 days
August	..	..	1.19 in 8 days
September	..	..	0.60 in 6 days
October	..	..	1.52 in 5 days
November	..	..	2.25 in 9 days
December	..	..	5.58 in 13 days
Total	..	..	27.70 in 90 days
			32.47

The average rainfall for the 15 years of recording at the station, 1941-1955, is 32.15 in.

The rainfall for February is the highest recorded since 1941 and a rainfall over 5 in. in December has only been recorded four times before, of which two were in exceptionally wet years.

Although the total rainfall is below normal the distribution was good and growth rates were maintained during the year.

Nursery Trials

NURSERY MANURIAL AND MULCHING TRIAL

Object.—To compare the effects of fertilizers and sisal waste on the growth rate of bulbils in nurseries.

Date of Commencement

First cycle planted 28th November, 1950, lifted one year and four months later.

Second cycle planted 15th April, 1952, lifted one year and seven months later.

Third cycle planted 24th November, 1953, lifted one year five months later.

Fourth cycle planted 18th April, 1955.

Spacing.—2 ft × 9 in. (29,040 plants per acre).

Treatments.—

N. 300 lb. sulphate of ammonia per acre.

K. 120 lb. muriate of potash per acre.

P. 180 lb. double superphosphate per acre.

C. 30 tons well rotted sisal waste dug in per acre.

M. 30 tons well rotted sisal waste mulched per acre.

Design.— 2^5 factorial confounded.

The weights of plants lifted after the first and second cycle were published in the Annual Report for 1953.

The average weight of the plants at the end of the third cycle was considerably less than the two previous cycles varying around $2\frac{1}{2}$ lb. per plant with no significant difference between the treatments although the rainfall, rainfall distribution and original plant size were about the same as in the previous cycles.

The variations in weedgrowth in the plots are quite clear with the plots receiving sisal waste having a considerably greater amount of weed.

There are signs indicating a greater unevenness in the waste plots, which may be due to the plants being planted within a few days of the application of waste, which may be too soon.

If the total weight of plants removed per acre over the three cycles is compared it is found that with the N application six tons and with sisal waste dug in, 11.8 tons more planting material was removed per acre compared to the areas not receiving these treatments; in the P application and where sisal waste was applied as a mulch the increase only amounted to just over two tons after the three cycles. A K application had, on the other hand, depressed this amount by four tons.

In the fourth cycle there are noticeable variations in size of plants in the sisal waste plots, while those without waste grow more evenly.

NURSERY NITROGEN AND LIME TRIAL

Object.—To ascertain the effect on soil and sisal plants of various nitrogenous fertilizers.

Date of Commencement

First cycle planted 16th April, 1953; lifted 8th November, 1954.

Second cycle planted 15th November, 1954.

The second cycle is scheduled to be lifted in 1956, so no new results were obtained in 1955. There were no significant differences in the weight of the plants lifted at the end of the first cycle.

Planting Material Trials

PLANTING METHOD TRIAL

Object.—To compare yields when using graded old suckers from overgrown fields, graded young suckers from two-year-old fields and graded nursery plants produced from bulbils.

Date of Commencement.—24th April, 1949.

Spacing.—12 ft. $\times$ 2 ft. 6 in. (1,452 plants per acre).

*Treatments**Planting Material*

Old suckers 19 in. high, weighing 6 lb.

Young suckers 15 in. high, weighing $1\frac{1}{2}$ lb.

Nursery plants 18 in. high, weighing 4–5 lb.

*Depth of Planting**Deep*

7 in. deep for young suckers.

9 in. deep for old suckers and nursery plants.

Shallow.—Approximately 3 in. deep for all three planting materials.

Design.—6 × 6 Latin square.

At the recording in November, 1955, the differences between the three planting materials in total number of leaves produced since planting were small and insignificant.

The shallow-planted plants with an average of 219 leaves were significantly better than the deep-planted with an average of 208 ($P = 0.01$).

The leaf length of the young suckers is still slightly shorter than the other planting materials and it would appear that the cutting is affecting the leaf length more. This is probably due to the fact that all the plants were cut when they had produced a given number of leaves after planting and the young suckers, starting off with a lower leaf count, received a comparatively earlier cut.

All treatments had a fourth cut in January, 1955, and a pole cut was given in June, 1955. The poling percentage is now 43 per cent for old suckers, 39 per cent for nursery plants and 20 per cent for young suckers.

The average number and weight of leaves cut per plant is for young suckers 132 leaves weighing 161 lb. against about 151 leaves at 204 lb. for the two bigger planting materials. Young suckers have also produced about 0.80 tons line fibre less than the 3.92 tons produced by the bigger planting material. These differences are significant.

Shallow-planted has in all yield figures been at an advantage over deep-planted although the differences have not been big enough to be statistically significant

PLANTING MATERIAL TRIAL

Object.—To investigate the possibility of obtaining greater efficiency by using larger nursery plants and to investigate the effect of an earlier first cut than is normal practice in Kenya.

Date of Commencement.—3rd November, 1950.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

*Treatments**Planting Material*

Nursery plants 9 in. high, weight about 1 lb.

Nursery plants 15 in. high, weight about $3\text{--}3\frac{1}{2}$ lb.

Nursery plants 21 in. high, weight about $6\frac{1}{2}\text{--}7$ lb.

Development at First Cut

Early: 80-90 leaves produced since planting.

Normal: 100-110 leaves produced since planting.

Late: 120-130 leaves produced since planting.

Intensity of Cut

Heavy: Leaving 25 leaves after first cut.

20 leaves after subsequent cuts.

Medium: Leaving 35 leaves after first cut.

30 leaves after each subsequent cut.

Light: Leaving 45 leaves after first cut.

40 leaves after each subsequent cut.

Design.—3³ factorial confounded. Two replications.

At the last recording in November, 1955, the average number of leaves produced per plant since planting was 171, and the variations between treatments were insignificant. The biggest planting material had, however, produced the highest number of leaves, namely 177, as well as the longest leaf of 115 centimetres. The average leaf length over the trial was 110 centimetres and differences were not big enough to be significant.

The whole trial had a third cut in May, 1955, and is now in a regular yearly cutting cycle. Variations in time between the first three cuts were introduced to bring all the plots into cutting at the same time, so the periods between cuts varied from 16 and 14 months in the earliest cuts to eight and nine months in the latest first cuts.

The results after the third cut are as follows:—

	No. of leaves cut per plant	Weight of leaves cut	Tons of fibre per acre	No. of leaves in thousands needed per ton of fibre	
				3rd cut only	Average of 3 cuts
		<i>lb.</i>			
Planting Material:					
9 in. 	83	100	2.18	60	83
15 in. 	83	95	2.17	56	79
21 in. 	95	126	2.90	47	68
1st cut at:					
80-90 leaves ..	91	105	2.50	56	78
100-110 leaves ..	87	103	2.30	54	79
120-130 leaves ..	83	113	2.46	52	73
Cutting Intensity:					
Leaving 25 leaves..	97	124	2.85	49	72
Leaving 35 leaves..	88	111	2.49	52	75
Leaving 45 leaves..	76	87	1.93	61	83

The biggest size planting material has again been superior and clearly demonstrates the advisability of planting big nursery plants.

The influence of the earliest first cuts on leaf size is indicated by the number of leaves needed per ton of fibre being larger than in the delayed first cut. It is of interest that the latter treatment has yielded a greater weight of leaves cut per plant from a smaller number of leaves.

It would not be correct to judge the effect of the cutting intensity on leaf size from these intermediate figures as the heaviest cut has had about 20 more leaves cut off per plant than the lightest cut, and these leaves are at present so big that they give the smaller figure for leaves needed per ton of fibre.

BULBILS, NURSERY PLANTS AND SUCKERS TRIAL

Object.—To compare bulbils planted *in situ* in the field with nursery plants and suckers, and further to compare flat and ridged planting on red soils.

Date of Commencement.—7th November, 1950.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments

Bulbils—Average weight 3 oz., planted *in situ* in fields.

Nursery plants—15 in. high, weight 3–3½ lb.

Suckers from old areas—25 in. high, weighing 10–12 lb.

Ridged vs. flat.

Design.—6 × 6 Latin square.

Although both nursery plants and suckers have been cut twice the bulbils will only be ready for a cut at the age of about 5½ years and are much more uneven than the other planting materials.

It is clear that the bulbils are best planted in a nursery to develop before planting out. By planting them straight out in the field the result is uneven plants and a delayed first cut, both undesirable features, indicating that any mechanical planter which may be invented must be based on bigger planting material.

The average number of leaves produced since planting by nursery plants and suckers is about 165, the ridged plants having produced only seven leaves more per plant than the flat-planted, with very little difference in the length of leaves.

The yield figures after the second cut are as follows:—

	Nursery plants	Suckers	Mean
No. of Leaves Cut—			
Ridged	77	98	87.5
Flat	71	89	80
Mean	74	93.5	
Weight of Leaves Cut—	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Ridged	117	152	135
Flat	101	131	116
Mean	109	141.5	
Tons of Fibre per acre—	<i>tons</i>	<i>tons</i>	
Ridged	2.3	3.3	2.8
Flat	2.0	2.8	2.4
Mean	2.2	3.0	

The suckers had about 10–15 leaves more per plant at planting, which may explain the better results to date, but this should be more obvious when poling commences.

More detailed information would be needed on which to base recommendations for ridging, as the cost may not be justified by the increased yields at present and must be based on final yield variations.

GRADING OF PLANTING MATERIAL TRIAL

Object.—To investigate which factor or factors mostly influence the evenness of growth in height of plants in sisal fields.

Date of Commencement.—17th April, 1952.

Spacing.—13 ft × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments

Height: When transplanting from nursery to field 18 in. from ground level to tip of central spike.

Girth: 11½ centimetres in diameter at base of plant.

Weight: Ranging from 5 lb. 10 oz. to 6 lb. 6 oz.

Design.—2³ partially confounded.

Cutting started in this trial in June, 1955, when the number of leaves produced since planting came into the range of 125–135. Only two plots remained uncut at the end of 1955.

This trial will be discontinued after the first cut as the cutting may influence the evenness of the plants.

The results from this trial indicate the advisability of grading planting material even when moving plants from a fairly even nursery and that grading plants for height will give a more even field than grading for girth or weight. There are indications of the value of grading for weight especially if this is in combination with height when plants are lifted from an uneven nursery.

Grading for girth by itself, although producing more even plants than ungraded, does not appear to produce the even growth one would expect from the work involved.

The simplest way of grading is grading for height, which has given a very even stand of sisal. Grading for weight, which is difficult, also gave an even stand. A combination of the two appears to be the best method, although this may be practical only on estates with very uneven nurseries, aiming at a high standard in the fields.

The evenness is also reflected in the variations in length of leaves cut at the first cut when the smallest proportions of short leaf to long leaf were found when the grading done was either a combination of height and weight or height and girth.

CURED PLANTING MATERIAL TRIAL

Object.—To investigate the effect on nursery plants of a drying-out process for varying lengths of time before planting out in the field.

Date of Planting

Before long rains in April, 1953.

Before short rains in November, 1953.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments.—Drying in the sun and under cover for three, two and one month before planting in the long and short rains *vs.* planting of fresh material.

Design.—Randomized blocks, two replications.

The plants cured before the long rains, 1953, are now 2½ years old and any effect of curing should have become apparent by now. The growth rate figures from the October, 1955 recording are as follows:—

Dried before long rains, 1953, and planted April, 1953:—

		Leaf Count	Leaf Length	
No Drying		89.8	65.4 cm.	
Dried	In Shade	Without Shade	In Shade	Without Shade
			cm.	cm.
1 month	91.7	84.0	62.5	64.2
2 months	91.8	88.1	63.1	64.4
3 months	97.2	95.3	66.9	67.3

Dried before short rains, 1953, and planted, November, 1953:—

		Leaf Count	Leaf Length	
No Drying		65.4	78.9 cm.	
Dried	In Shade	Without Shade	In Shade	Without Shade
			cm.	cm.
1 month	62.5	64.2	77.5	81.4
2 months	63.1	64.4	74.7	71.7
3 months	66.9	67.3	90.0	73.2
Mean over:				
2 uncured plantings		77.6		72.2 cm.
2 plantings of cured plants.	78.9	77.2	89.1 cm.	86.4 cm.

The influence of shade during drying appears to be little, and of no consequence and too much importance should not be attached to the indication that longer curing appears preferable. The trial is too small to settle this point.

It is not proposed to carry this trial further, but it may be a subject of interest for further investigation in future programmes. The significant factor from this small trial is that the plants left unplanted for up to three months struck roots and grew normally: this indicates that it may be possible to spread a planting programme over a prolonged period, rather than to concentrate it just before the rains.

As the plants grew normally after drying-out lying on the ground, they may also do so if planted for a longer period before the rains. Taking advantage of every light shower in the dry period they should be able to benefit fully when the rains start.

Plant Management Trials

The object of the following five trials is to ascertain variations in growth rates in various districts of Kenya, using different spacing and cutting treatments. Treatments for spacings are as follows, with the figures in the body of the table giving the distance between plants in the row:—

Plant Populations per acre:		1200		1600		2000	
Row Spacing:	14'	×	31"	×	23"	×	18"
Row Spacing:	11'	×	39"	×	29"	×	23"
Row Spacing:	18' × 3'	×	41"	×	31"	×	24"

Development at First Cut:

100 leaves grown since planting.

125 leaves grown since planting.

150 leaves grown since planting.

Severity of Cutting:

Light: Leaving 30 leaves after each cut.

Medium: Leaving 20 leaves after each cut.

Heavy: Leaving 10 leaves after each cut.

Design: 34 factorial arranged as a 9×9 Quasi Latin Square.

The differences needed between two figures to be significant are expressed on two probability levels of 95 per cent and 99 per cent at the bottom of each column as $P = 0.05$ and $P = 0.01$, while each column represents one of the subjects under investigation.

RUIRU TRIAL (BACK COTTON SOIL) RIDGED

Locality.—Juja Farm, Ruiru.

Date of Commencement.—16th March, 1948.

The summary of recording for leaf count and leaf length at July, 1955, and totals after a pole cut in September, 1955, is as follows:—

	Average Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	169	39.4	89.9	98	2.27	67.8	26.1
11 ft.	175	39.0	91.9	106	2.44	66.5	31.8
18 ft. × 3 ft. ..	178	40.3	98.7	114	2.67	64.1	36.4
Population—							
1,200 per acre ..	193	42.0	117.4	143	2.70	54.9	59.6
1,600 per acre ..	170	38.2	86.5	92	2.27	67.7	22.0
2,000 per acre ..	159	38.5	76.6	78	2.41	75.8	12.8
First Cut at—							
100 leaves	180	38.1	110.0	116	2.93	67.5	25.5
125 leaves	173	39.1	97.4	108	2.40	69.6	30.4
150 leaves	169	41.4	72.2	90	2.06	61.4	38.5
Cutting—							
Light	174	40.3	89.0	100	2.42	67.7	34.1
Medium	175	40.2	94.5	111	2.53	65.3	35.7
Heavy	173	38.2	97.1	103	2.44	65.5	24.6
Difference required for significance—							
P=0.05	9	2.2	13.1	22	0.60	7.5	
P=0.01	12	2.9	17.6	29	0.81	10.1	

The unevenness in the soil in this trial is expressed in the big figures for P. The variations within the various plots are small while those between the plots are big.

Although much of the information hoped for has been nullified by the big differences required for significance it is still very valuable and must be borne in mind for future trials on black cotton soils.

Information on soils in Australia similar in behaviour to black cotton soils was obtained from Rothamsted Experimental Station, United Kingdom, but details on the handling are not available yet.

TRANS NZOIA TRIAL

Locality.—Ziwa Limited, Hoey's Bridge.

Date of Commencement.—10th April, 1948.

The summary of recording for leaf growth and cutting results made in October, 1955, is as follows:—

	Average Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
<i>Spacing—</i>		<i>in.</i>					
14 ft.	229	43·8	147	196	4·14	57·2	6·4
11 ft.	242	44·0	159	220	4·84	53·2	10·8
18 ft × 3 ft.	233	43·2	150	200	4·21	55·6	12·2
<i>Population—</i>							
1,200	253	44·2	173	249	4·29	49·4	21·2
1,600	234	43·8	151	204	4·46	54·3	6·5
2,000	218	43·0	132	162	4·45	62·3	1·6
<i>First Cut at—</i>							
100 leaves	234	42·7	155	192	4·27	57·0	8·0
125 leaves	233	43·0	150	198	4·19	57·6	4·1
150 leaves	238	45·3	152	225	4·74	51·4	17·3
<i>Cutting—</i>							
Light	238	46·3	143	199	4·12	54·6	14·5
Medium	236	44·4	153	213	4·62	53·7	11·3
Heavy	231	40·2	159	203	4·45	57·7	3·6
<i>Difference required for significance—</i>							
P=0·05	3·0	0·7	4·4	11	0·33	2·3	
P=0·01	4·0	1·0	5·9	14	0·45	3·0	

This trial is the most even of the five external spacing and cutting trials and is yielding satisfactory results. The amount of fibre per acre is gratifying after only 7½ years in spite of the leaves being slightly shorter than those from plants growing at a lower altitude. When comparing fibre yields it should be borne in mind that the lowest population is 35 leaves nearer completion than the highest population and these 35 leaves per plant times 2,000 plants per acre will make a difference in the final yield figures which is not apparent at present.

KAMPI-YA-MOTO TRIAL

Locality.—Alphega Estate, Kampi-ya-Moto.

Date of Commencement.—23rd October, 1948.

A summary of results obtained from recording of growth rates and cutting in October, 1955, is given below:—

	Average Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
Spacing—		<i>in.</i>					
14 ft.	179	41.6	109.0	134.1	2.69	73.0	21.4
11 ft.	188	42.1	118.7	149.6	3.05	66.1	25.4
18 ft. × 3 ft.	171	37.6	98.5	104.6	2.07	82.5	9.8
Population—							
1,200	193	42.0	125.3	160.0	2.54	65.2	33.2
1,600	181	40.7	111.1	132.1	2.75	70.9	19.3
2,000	163	38.6	89.9	96.2	2.52	85.5	4.2
First Cut at—							
100 leaves	179	39.0	118.1	130.3	2.75	75.2	14.6
125 leaves	181	40.6	113.2	135.3	2.76	70.2	22.4
150 leaves	177	41.6	95.0	122.6	2.31	76.2	19.6
Cutting—							
Light	179	41.1	99.5	117.5	2.33	74.7	19.2
Medium	178	40.1	107.9	128.6	2.59	76.5	19.3
Heavy	180	40.0	118.9	142.1	2.89	70.4	18.2
Differences required for significance—							
P=0.05	5.2	2.1	7.6	15.6	0.35	10.2	
P=0.01	7.0	2.8	10.2	21.0	0.47	13.7	

This trial grows on a piece of poor and rather unven soil which is below the fertility of the surrounding country. There are indications that 2,000 plants per acre is too much on soil of this nature.

THIKA TRIAL (RED SOIL)

Locality.—Anglo-French Estate, Thika.

Date of Commencement.—17th November, 1948.

A summary of the results obtained from recording of plant growth in September, 1955, and cutting in August, 1955, is given below:—

	Average Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
Spacing—		<i>in.</i>					
14 ft.	202	44.5	129	171	3.65	56.9	12.5
11 ft.	220	45.0	145	210	4.62	50.5	22.1
18 ft. × 3 ft.	204	43.1	121	159	3.41	58.0	8.3
Population—							
1,200	228	44.6	152	224	3.83	49.7	28.9
1,600	208	44.0	128	173	3.88	54.7	8.0
2,000	190	44.1	115	143	3.98	61.0	6.2
First Cut at—							
100 leaves	212	43.2	144	175	4.05	58.7	13.7
125 leaves	209	43.1	135	184	3.92	57.3	8.1
150 leaves	206	46.4	116	181	3.72	49.4	21.1
Cutting—							
Light	209	45.5	124	175	3.69	55.5	20.5
Medium	206	44.1	125	170	3.65	56.0	12.5
Heavy	211	43.1	145	195	4.34	53.9	9.6
Difference required for significance—							
P=0.05	3.3	1.0	10.9	12.0	0.34	2.6	
P=0.01	4.5	1.4	14.7	16.1	0.45	3.4	

Although this trial grows on land which has been under sisal for a considerable number of years it has grown very well and very evenly.

The results after seven years growth are good and when poling becomes more general should give valuable information.

KIBWEZI TRIAL

Locality.—Dwa Plantations Limited, Kibwezi.

Date of Commencement.—21st October, 1949.

The summary for recording of leaf growth and cutting results at November, 1955, are as follows:—

	Average Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
	<i>in.</i>						
Spacing—							
14 ft.	168	48.3	107	144	3.67	46.5	24.7
11 ft.	178	48.3	120	166	4.36	44.5	41.2
18 ft. × 3 ft.	171	48.2	105	139	3.55	47.0	24.1
Population—							
1,200	187	49.6	134	190	3.83	42.6	57.8
1,600	172	47.7	107	145	3.87	45.6	25.6
2,000	158	47.4	91	114	3.88	49.8	6.7
First Cut at—							
100 leaves	173	45.5	120	143	3.84	50.0	15.0
125 leaves	173	48.1	117	158	4.05	46.7	32.7
150 leaves	171	57.1	95	148	3.69	41.3	42.3
Cutting—							
Light	174	49.8	111	152	3.96	45.1	36.2
Medium	171	47.9	108	143	3.69	46.4	27.5
Heavy	171	47.0	113	154	3.93	46.4	26.4
Difference required for significance—							
P=0.05	4	1.1	5	12	0.31	2.3	
P=0.01	5	1.5	7	16	0.42	3.1	

This trial is growing so well that a cutting cycle of nine months has had to be introduced to avoid losing leaves.

The incidence of bole rot in this trial is related to cutting and is especially pronounced in the severity of cutting treatments where it occurs more severely in the heaviest cut treatments.

Summary of Results from External Spacing and Cutting

EFFECT OF ROW SPACING

The plants growing in the 11-ft. spacing have generally developed faster than in the other spacings under observation, which is attributed to the greater distance between the plants in a row when the distance between the rows is reduced, and the plant population remains the same.

The more rapid development per plant has led to slightly more fibre and a higher poling percentage in most cases.

EFFECT OF POPULATION

The relation between plant population and the rate of development of the individual plants is clearly demonstrated in all trials, with a higher leaf count per plant in lower population. Only in the Juja trial and Kampi ya Moto trial are there indications that the higher populations will produce a shorter leaf. In the other trials the length of each leaf is related to the leaf number so it would be reasonable to expect that when the leaf counts (with the shorter leaf at present) in the higher populations reach the leaf count of the lower population, the leaves will be about the same length.

The variations in fibre yields are small at present but must be seen in relation to poling percentage. The greater number of leaves needed per ton of line fibre in the higher populations is due to the cutting of older leaves, i.e. shorter leaves grown earlier in the plant's life and must be reviewed when the poling percentage approaches that of the smaller populations. The advantage of getting the same yield with a smaller poling percentage must be borne in mind.

EFFECT OF EARLINESS OF FIRST CUT

This factor has had very little effect on the number of leaves produced per plant but has had a pronounced effect on the length of the leaves. In all cases has the length of the leaves produced subsequent to the first cut been related to the development of the plant at first cut, with the result that the earliest cut has not only retarded the length of the leaves produced subsequently, but in some cases the leaves are actually shorter than those produced earlier in the plant's life.

The tonnage of fibre produced per acre must be considered in relation to the number of leaves needed to produce a ton of fibre as an increase in fibre based on more leaves per ton may not always be the most economical result.

The fact that the earliest first cuts have delayed poling is of interest and will be subject to further investigations when the poling is more advanced.

EFFECT OF INTENSITY OF CUT

The intensity of the cuts has had very little effect on the number of leaves grown per plant but the heavier cuts have reduced the length of the leaves grown subsequently.

The heaviest cuts have so far produced slightly more fibre with fewer leaves per ton, but when a comparison is made the greater number of leaves left on the plants in the lighter cuts must be borne in mind.

DOUBLE- vs. SINGLE-ROW TRIAL

Object.—To compare various plant populations and row spacings, and to establish whether a certain plant population will perform equally well whether planted in single row or in double rows, when the distance between rows is the same.

Date of Commencement.—15th April, 1952.

Treatments Populations.—1,600 plants per acre, 2,000 plants per acre, 2,400 plants per acre.

Distance Between Rows.—11 ft.; 13 ft.

Row Spacing.—Double rows, 3 ft. between rows; single rows.

Design.— $3 \times 2 \times 2$, partially confounded.

The recording for October, 1955, showed that there were no significant differences in the results obtained for leaf length.

The results for leaf count are as follows:—

*Difference required
for significance*

1,600 plants per acre	131 leaves per plant	} $P=0.05=5.6$ $P=0.01=7.6$
2,000 plants per acre	122 leaves per plant	
2,400 plants per acre	115 leaves per plant	
Row Spacing: 11 ft.	125 leaves per plant	} $P=0.05=4.6$ $P=0.01=6.2$
13 ft.	120 leaves per plant	
Double Row	127 leaves per plant	
Single Row	119 leaves per plant	

In the smaller populations the rate of leaf growth is faster but it must be borne in mind that the total number of leaves per acre is less:—

1,600 plants per acre $\times$ 131 = 209,600 leaves per acre.

2,000 plants per acre $\times$ 122 = 244,000 leaves per acre.

2,400 plants per acre $\times$ 115 = 276,000 leaves per acre.

The 11-ft. row spacing with the plants wider in the row is just significantly better than the 13-ft. row spacing.

The double row with the greater growing space per plant has induced faster growing plants in all the populations under observation as follows:—

Leaf Count

Plants per acre	..	..	1,600	2,000	2,400	Mean
Double Row	..	..	134	125	121	127
Single Row	..	..	128	120	109	119
Mean	..	..	131	122	115	

Twenty-five of the 36 plots were cut during 1955 when the average number of leaves produced since planting amounted to 120–130. Most of these plots were from the lower population planted in double rows.

Cultivation Trials

CULTIVATION TRIAL

Object.—To investigate the effect on the soil and sisal plants of continuous clean weeding by mechanical means as against restricted weeding with and without a controlled grass cover in the area between sisal lines.

Date of Commencement.—1st November, 1950.

Spacing.—13 ft. $\times$ 3 ft. $\times$ 2 ft. 9in. (1,980 plants per acre).

Treatments

- (1) Grass strip slashed frequently to keep grass low.
- (2) Grass strip cut periodically and the cut grass used as mulch round sisal plants.
- (3) Clean weeded by frequent discing for the first three years, then as (2).
- (4) Clean weeded by frequent discing for the first three years, then discing twice a year.
- (5) Discing twice a year for the whole cycle.
- (6) Clean weeding by frequent discing for the whole cycle.

This trial incorporates the above treatments with sisal planted on the flat and on ridges. The grass cover is obtained by sowing Rhodes grass (*Chloris gayana*) in 6-ft. wide strips between the double rows.

Design.—Rectangular lattice square with four replications.

The average number of leaves produced per plant is 193 and variations between the cultural treatments are insignificant.

The ridged plants have on an average produced only about three leaves more per plant than the flat-planted, and as this has so far amounted to less than a quarter of a ton more in fibre, would indicate that on this well-drained deep red soil the expense of ridging would not be justified by more or longer leaves.

The growth rate in this trial is very fast owing to the initial high fertility of the soid. With a cutting interval of a year, leaves began to dry up and were lost, so the cutting cycle has been reduced to six months with 30 leaves left after each cut.

The average yields taken off are as follows:—

1st cut	8-6-1953	0.84 tons of fibre.
2nd cut	23-6-1954	1.19 tons of fibre.
3rd cut	1-2-1955	0.93 tons of fibre.
4th cut	13-7-1955	1.17 tons of fibre.

Total to date 4.13 tons of fibre per acre.

with an average of about 6 per cent poling.

To get a yield of this magnitude in four years eight months is quite outstanding and must be attributed to high fertility of the soil.

The various cultural treatments have not influenced the yields to a significant extent. This trial will be of greater interest after two or three cycles when the cultural treatments may have an effect on the soil in a loss of structure by the constant discing. Greater competition between the grass and the sisal may also become apparent when the fertility is lowered after a series of sisal cycles.

Fertilizer Trials

FERTILIZER TRIAL

Object.—To investigate the effect on the growth rate of sisal plants by applying artificial fertilizers and/or sisal waste.

Date of Commencement.—16th March, 1950.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments

Ca = Agricultural lime (96 per cent CaCO_3), broadcast over the whole treated area at the rate of two tons per acre, a month before planting.

W = Sisal waste as fresh sisal waste taken straight from a Corona decorticator, decorticating dry. The waste was applied at the rate of 107 tons wet waste per acre and dug in one month before planting in strips covering an area 4 ft. each side of the double rows.

N = Sulphate of ammonia applied at the rate of 388 lb. per acre in each of the first four years of the cycle.

P = Double superphosphate, applied in shallow trenches under the plants a week before planting at the rate of 260 lb. per acre. As the effect was quick but only lasted for about 18 months an extra application at the rate of 150 lb. double superphosphates was given after three years.

K = Muriate of potash, applied at the rate of 395 lb. per acre for the first year and 300 lb. per acre during each of the next three years.

Design.— 2^5 factorial.

At the recording for leaf growth in October, 1955, the effects of Ca, P and K were not significant in both leaf count and leaf length figures; the leaf count being in the range of 187 ± 2 and the length of the last leaf 40 in. $\pm \frac{1}{2}$ in.

The sisal waste application maintained its superiority and the applications of sulphate of ammonia also continued to produce vigorous plants. The differences between plants with and without these fertilizers are as follows:—

			Leaf count and leaf length of plants without		Leaf count and leaf length of plants with	
W	..	..	176.7	38.4 in.	197.2***	41.2 in.***
N	..	..	180.7	38.8 in.	193.2**	40.8 in.*

P=0.05*

P=0.01**

P=0.001***

All interactions between the various fertilizers are small in leaf length, and only the interaction between sisal waste and sulphate of ammonia is of interest in leaf count as follows:—

Control	N	W	N+W
169.4	184.1	192.1	202.2

P=0.05=8.6

P=0.01=12.0

The trial had its third cut in January, 1955, and the effect of the fertilizers on yields can best be expressed as follows:—

	Ca	W	N	P	K
Average No. of leaves cut per plant—					
With fertilizers ..	89.3	96.7	92.3	91.4	85.1
Without fertilizers	84.5	77.1	81.5	82.4	88.7
Effect	4.8	19.6***	10.8**	9.0*	—3.6
Average weight of leaves in lb. cut per plant—					
With fertilizers ..	100.4	112.3	103.5	102.0	94.5
Without fertilizers	90.4	78.4	87.3	88.8	96.3
Effect	10.0	33.9***	16.2**	13.2*	—1.8
Tons of fibre per acre—					
With fertilizers ..	2.25	2.56	2.35	2.33	2.12
Without fertilizers	2.06	1.76	1.97	1.98	2.20
Effect	0.19	0.80***	0.38**	0.35*	—0.08
No. of leaves in thousands per ton of fibre average over three cuts—					
With fertilizers ..	80.8	76.7	81.2	80.2	83.3
Without fertilizers	85.5	89.6	85.1	86.1	83.0
Effect	—4.7*	—12.9***	—3.9	—5.9**	0.3

P=0.05*

P=0.01**

P=0.001***

On the information available from these figures it can be stated that a heavy application of sisal waste has speeded up the initial growth, shortened the unproductive period before the first cut and within the period in question has given a higher fibre yield for a smaller number of leaves per ton of fibre.

The first two statements will stand whatever the final yield is going to be in the plots not receiving sisal waste. As the plants growing in sisal waste are developed better to the extent of 20 leaves per plant, or about 40,000 per acre, they have obviously given more fibre to date. Whether this will be so in the final cut remains to be seen. It is of economic importance to note the smaller number of leaves needed per ton of fibre in the three cuts taken to date.

SISAL WASTE AND MINERALS TRIAL

Object.—To compare the effect of different methods of applying fresh sisal waste, sisal waste reinforced with artificial fertilizers and artificial fertilizers alone.

Date of Commencement.—17th March, 1950.

Treatments

Treatments	Fresh sisal waste	Sulphate of ammonia	Double super-phosphate	Muriate of potash	Agric. lime (Ca CO ₃ , 96%)
	<i>tons</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>tons</i>
A. Control	Nil	Nil	Nil	Nil	Nil
B. Waste half dug in and half as mulch ..	107	Nil	Nil	Nil	Nil
C. Waste dug in ..	107	Nil	Nil	Nil	Nil
D. Waste all as mulch ..	107	Nil	Nil	Nil	Nil
E. Waste half dug in and half as mulch with minerals added ..	107	390	65	325	0.42
F. Waste dug in with minerals added ..	107	390	65	325	0.42
G. Waste all as mulch with minerals added ..	107	390	65	325	0.42
H. Minerals only ..	Nil	1,560	260	1,300	2.0

The waste, lime and superphosphate were applied before planting as in the fertilizer trial. Sulphate of ammonia applied with waste at the rate of 129 lb. per acre for the first year and 87 lb. per acre during each of the next three years. Applied without waste at the rate of 522 lb. for the first year and 346 lb. per acre during each of the next three years.

Muriate of potash applied with waste at the rate of 130 lb. per acre the first year and 65 lb. during each of the next three years. Applied without waste at the rate of 520 lb. per acre for the first year and 260 lb. during each of the next three years.

Design.—Four randomized blocks of eight plots.

The following figures were obtained from the recording for growth in October and from the cutting in January, 1955:—

	No Artificial Fertilizers				Artificial added				P=0.05	P=0.01
	A.	B.	C.	D.	E.	F.	G.	H.		
Leaf count	177	188	189	191	201	198	195	192	17	23
Leaf length	40.2"	39.1"	38.7"	40.0"	43.6"	40.8"	42.0"	39.6"	4.8	6.6
Av. No. of leaves cut per plant	79.7	88.9	87.8	90.0	102.8	100.9	97.9	93.5	14.1	19.1
Av. wt. of leaves cut per plant	85.9	92.5	91.7	96.3	126.5	116.3	110.8	105.2	27.6	37.6
Tons of fibre per acre ..	1.93	2.20	2.20	2.29	2.88	2.69	2.75	2.47	0.61	0.83
No. of leaves in thousands per ton of fibre	89.3	81.0	81.1	78.9	75.5	74.8	75.7	76.2	10.5	14.3

Comparing control (A) with the various ways of applying sisal waste it is found that the differences are not big enough to be significant.

The soil variations within this trial are big so that the various ways in which sisal waste has been applied have not influenced the plants to an extent which would create statistically significant differences.

The application of artificials without sisal waste (H) has had an effect on the plant of the same order as that of sisal waste.

The addition of artificials to sisal waste has had a beneficial effect on the plants although not significantly so and at present it is questionable whether the expense is going to be worthwhile or not.

ROTATIONAL FERTILIZER TRIAL

Object.—To investigate the effect on sisal of resting the land under grass for a period of years between the cycles with and without a grass cover during the cycle. These treatments are combined with fertilizer treatments on bare land and grass strips between the sisal rows.

Locality.—Anglo-French Sisal Estate, Thika.

Date of Commencement.—24th November, 1952.

Treatments

1st Cycle	2nd Cycle
(1) Clean weed by frequent discing throughout.	As first cycle.
(2) Plant grass strips, cut grass and mulch along sisal rows.	As first cycle (sisal replanted where grass strips were).
(3) Plant grass strips, cut grass and mulch along sisal rows.	Leave grass strips to cover land for three years; then replant sisal and treat as first cycle.
(4) Clean weed by frequent discing throughout.	Three years grass ley then as first cycle.

Superimposed on the above treatments are the following fertilizer treatments:—

Control, N, P, Ca, NP, NCa, PCa and NPCa.

Sulphate of Ammonia (N).—200 lb. per acre for the first four years of the cycle.

Double Superphosphate (P).—150 lb. per acre at planting.

Agricultural Lime (Ca).—Two tons per acre just before planting.

Design.—Six randomized blocks of four plots each. Each plot split for N, P and Ca (24 plots or 96 split plots).

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Grass (*Melinis minutiflora*) strips planted in April, 1953 and interplanted in November have grown well and a good grass cover is established.

The differences between the clean weeded plots and those in which grass has been introduced are small and just statistically significant. The clean areas have produced about 93 leaves per plant which is just over three leaves more per plant than the areas under grass.

The responses to the fertilizers are greatest where N and/or P have been applied, but the variations are small. P has increased the leaf number by 4.2 leaves per plant while N has increased it by 1.9. The combined effect is an increase of 5.8 leaves per plant. There has been no significant response to the application of lime.

The interactions between cultivation and fertilizers treatments are not big enough to warrant comment.

FERTILIZER, WASTE AND GRASS TRIAL

Object.—To investigate the effect of N, P, Ca, and sisal waste on old sisal land with and without grass strips introduced between the sisal lines.

Locality.—Anglo-French Sisal Estate, Thika.

Date of Commencement.—3rd December, 1952.

Treatments.—The following applications were applied singly and in all possible combinations:—

W = Sisal waste: collected from a rotary pulp extractor and applied at the rate of 20 tons per acre in 6-ft. strips covering the planting lines.

N = Sulphate of ammonia: 200 lb. per acre applied close to plants in April, 1953.

P = Double superphosphate: 150 lb. per acre applied as 108 lb. per acre at planting by dropping $\frac{7}{8}$ oz. under each plant. The balance applied in the centre of the wide space between the double rows in April, 1953.

Ca = Agricultural lime: at the rate of two tons per acre applied broadcast on first December, 1952.

G = Grass: molasses grass (*Melinis minutiflora*) planted as strips between the sisal rows in April, 1953.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Design.—2⁵ factorial confounded.

The recording for September, 1955, shows that the average number of leaves produced per plant varied little from an average of 85 ± 1 and was non-significant for all treatments with exception of sisal waste which had increased the leaf count from 79.6 to 90.6 or an average of 11 leaves more per plant ($P = 0.01$) and has so far increased the length of the last leaf by 4.7 in.

There was a significant response to lime which lasted for about $2\frac{1}{2}$ years but it only amounted to an increase of approximately four leaves per plant and these leaves were too short to be of commercial interest.

The grass *Melinis minutiflora* planted in strips between the sisal in half of the plots has not had any depressing effect on the plants so far.

The outstanding feature of this trial is the rather spectacular effect obtained with sisal waste at this low rate of application. This is, no doubt, due to the fact that the area was planted with sisal for the first time in 1925, and carried two cycles yielding 3.17 tons per acre and 3.25 tons per acre of fibre respectively before being reclaimed in 1952.

EXPLORATORY FERTILIZER TRIAL, DWA

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on a soil which has been under sisal for a lengthy period in the Kibwezi area.

Locality.—Dwa Plantations Limited, Kibwezi.

Date of Commencement.—18th April, 1953.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments.—Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at rates of:—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime two tons per acre.

The plots were split for an application of sulphate of ammonia in March, 1954.

Design.—2⁵ factorial confounded.

The rate of leaf production has been much faster in this trial than in any of the other exploratory trials.

The average increase in leaf number per plant has been three leaves per month since planting, and the average leaf count per plant was 96 when the trial was two years seven months old.

There has been highly significant response to sisal waste. The following figures show the effect of waste on the average leaf count and average leaf length per plant:—

	Control	25 tons sisal waste	50 tons sisal waste	100 tons sisal waste
Leaf count	86.1	93.9	98.9	105.1
Leaf length	40.8"	44.8"	46.6"	49.5"

The effect of sulphate of ammonia has been an increase in leaf count of about four leaves per plant after 1½ years.

EXPLORATORY FERTILIZER TRIAL, ZEA

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on old sisal land in the Kitale area where symptoms of deficiency diseases have been noticed on sisal.

Locality.—Zea Estate Limited, Kitale.

Date of Commencement.—9th July, 1953.

Spacing.—13 ft × 3 ft. × 2 ft 9 in. (1,980 plants per acre).

Treatments.—Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at the rates of:—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime, two tons per acre.

Sulphate of ammonia, $2\frac{1}{2}$ cwt. before each rain for three years commencing April, 1954.

Design.— 2^5 factorial confounded. The plots were split for sulphate of ammonia.

The trial was recorded in October, 1955, and although the sub-plots with sulphate of ammonia have only produced an average of three leaves more per plant they were outstanding in the size of the plants and length of leaves.

The phosphate and lime applications have not had any significant effect on the growth rate of the plants but sisal waste has increased the number of leaves per plant, especially in the heavier applications.

	No. of leaves	Length of last leaf
Average of 8 plots not receiving sisal waste	53.8	23"
Average of 8 plots with 25 tons sisal waste	55.4	23.7"
Average of 8 plots with 50 tons sisal waste	61.0	24.9"
Average of 8 plots with 100 tons sisal waste	65.5	26.1"

The long-term effect of the sisal waste may be seen as follows:—

Increase in leaf count over control	After 15 months	After 27 months
25 tons sisal waste	2.1	1.6
50 tons sisal waste	5.9	7.2
100 tons sisal waste	9.2	11.7

From the above table one may see the first indication of the falling off of the effect of the small application of sisal waste.

RATES OF APPLICATION TRIAL

Object.—To ascertain the optimum rates needed for an economic return from sisal waste, double superphosphate, sulphate of ammonia and agricultural lime.

Locality.—High-level Sisal Research Station, Thika.

Date of Commencement.—10th October, 1954.

Spacing.—13 ft. $\times$ 3 ft. $\times$ 2 ft. 9 in. (1,980 plants per acre).

Treatments

Fresh sisal waste—

- 0 Nil.
- 1 25 tons per acre.
- 2 50 tons per acre.

Double superphosphate—

- 0 Nil.
- 1 181.5 lb. per acre (75 lb. P_2O_5).
- 2 363.0 lb. per acre (150 lb. P_2O_5).

Sulphate of ammonia—

- 0 Nil.
- 1 $2\frac{1}{2}$ cwt. per acre in two applications per annum.
- 2 5 cwt. per acre in two applications per annum.

Agricultural lime—

- 0 Nil.
- 1 2 tons per acre.
- 2 4 tons per acre.

Design.—3⁴ Quasi Latin Square.

The last recording took place in October, 1955, and as the trial was then only one year old the variations were small. Double superphosphate, sulphate of ammonia and lime gave no significant responses.

Sisal waste gave the following figures with highly significant differences:—

						Leaf count	Leaf length
No sisal waste	..	..	..	..	..	29.4	18.5"
25 tons sisal waste	..	..	..	..	..	33.3	19.3"
50 tons sisal waste	..	..	..	..	..	36.6	20.2"

all differences significant at $P=0.001$.

The whole trial is growing well, but it is still too early for further comment.

POOR LAND FERTILIZER TRIAL

Object.—To attempt to rehabilitate some very poor sisal, three years old, growing on exhausted and eroded land.

Locality.—High-level Sisal Research Station, Thika.

Date of Commencement.—Sisal originally planted March, 1950.

Treatments

Sisal waste—

- 50 tons after long rains, 1953.
- 50 tons before long rains, 1954.
- 50 tons before long rains, 1954, after removing lower leaves.

Sulphate of ammonia—

300 lb. per acre applied before long rains, 1954.

Double superphosphate—

150 lb. P_2O_5 as 365 lb., double superphosphate applied before long rain, 1954.

Agricultural lime—

Two tons per acre applied before long rains, 1953.

Design.— 2^5 factorial confounded.

The last recording of this trial took place in December, 1955, and the findings are as follows:—

There is no significant response to double superphosphate or to agricultural lime.

The response to the application of sisal waste is not significant as far as leaf count is concerned, but on leaf length, waste has had a small but detrimental effect which it is expected was caused by the excessively wet conditions when heavy rains of 8.5 in. fell during the first nine days after the application of the wet waste damaging roots and bole sufficiently to allow ingress of rotting organism. The plants appear to have grown out of this defect and now produce normal leaves.

The only significant response has been to sulphate of ammonia which alone and in all combinations has shown significant increases. Since the application of sulphate of ammonia before the long rains of 1954 the leaf count has been increased from 41.7 to 47.5 or by 5.8 leaves per plant while the increase in length amounted to 4.39 cm. from 92.2 cm. to 96.6 cm.

This is the first trial in which an endeavour has been made to prove that young, badly-grown sisal can be reinvigorated. More work must be done on these lines. The apparently negative results obtained should not be looked on as a waste of money but rather as an elimination of problems facing a grower. More and heavier applications of a nitrogenous fertilizer applied earlier in the plant's life should be tried as well as further applications of sisal waste applied at times other than close to the rains.

Further Exploratory Fertilizer Trials

The object of the following three exploratory fertilizer trials is to investigate the effect on the growth rate of sisal by applying fresh sisal waste at rates of $12\frac{1}{2}$, 25 and 50 tons at planting with additional applications at the same rate after 18 and 36 months, double superphosphate at the rate of 365 lb. per acre, agricultural lime at the rate of 2 tons per acre and sulphate of ammonia at the rate of 5 cwt. per acre per year for three years in two applications of $2\frac{1}{2}$ cwt. per acre before each rain.

The spacing in all three cases is 13 ft. $\times$ 3 ft. $\times$ 2 ft. 9 in. (1,980 plants per acre).

Design.— 2^5 factorial confounded.

EXPLORATORY FERTILIZER TRIAL, VOI

Locality.—Voi Sisal Estate Limited, Voi

Date of Commencement.—15th March, 1954.

Owing to the drought conditions under which this trial has had to grow since planting, there is very little response to the treatments and the rate of growth has been extremely slow.

The average number of leaves grown per plant from planting to the recording for November, 1955, amounted to only 21 or a growth of about one leaf per month, and only sisal waste has increased the leaf number:—

	No. Waste	12½ tons	25 tons	50 tons
Leaf Count ..	20.1	20.6	20.8	23.8

Although the differences between these figures are statistically significant, more information is required to support them.

Sulphate of ammonia has increased the length of the leaves by about an inch, but has so far had no effect on number of leaves grown.

EXPLORATORY FERTILIZER TRIAL, RUIRU

Locality.—B.E.A. Planting Co. Limited, Ruiru.

Soil.—Murram.

Date of Commencement.—2nd April, 1954.

The effects of the treatments imposed are clearly shown in the following table computed from the recordings in October, 1955:—

	Average leaf count of plants without	Average leaf count of plants with	Mean Effect
12½ tons sisal waste	45.2	48.4	3.2 (P=0.01)
25 tons sisal waste	43.7	49.9	6.2 (P=0.001)
Double superphosphate	44.7	48.9	4.2 (P=0.001)
Sulphate of ammonia	45.5	48.2	2.7 (P=0.01)
Agricultural lime	46.8	46.8	0.0

	Average length of last unfurled leaf of plants without	Average length of last unfurled leaf of plants with	Mean Effect
12½ tons sisal waste	24.8"	26.2"	1.3 (P=0.001)
25 tons sisal waste	24.2"	26.7"	2.5 (P=0.001)
Double superphosphate	24.2"	26.8"	2.6 (P=0.001)
Sulphate of ammonia	24.4"	26.5"	2.1 (P=0.001)
Agricultural lime	25.4"	25.6"	0.2 N/S.

The comparison between the rates of sisal waste application is as follows:—

	No waste	12½ tons waste	25 tons waste	50 tons waste
Leaf count ..	43.1	44.3	47.3	52.6
Leaf length ..	24.0"	24.5"	25.7"	27.8"

Several interactions look as if they may be of interest; for instance, waste/nitrogen, waste/phosphate and nitrogen/prosphate; but as the plants are so young it is felt the information should be confirmed by later recordings before publication of the figures.

EXPLORATORY FERTILIZER TRIAL, KAMPI-YA-MOTO

Locality.—Lomolo Sisal Estate, Kampi-ya-Moto.

Date of Commencement.—16th November, 1954.

This trial is growing well and has in the 18 months of growth till the recording in October, 1955, grown an average of 38 leaves per plant with the last leaf recorded being just over 2 ft. in length.

The effects of the applications of double superphosphate and agricultural lime are at present too small to be of any significance.

Only the higher applications of 25 and 50 tons of sisal waste have had a significant effect on the growth rate, increasing the leaf count by about four leaves per plant.

The effect of sulphate of ammonia is the greatest to date, both in leaf count and leaf length, expressed as follows:—

	Leaf count	Leaf length
With N	40.76	25.9"
Without N	35.78	23.8"
Increase	4.98 leaves	2.1"

both significant at $P=0.001$.

There is not enough information available yet to comment freely on the interactions between the various fertilizer applications.

Production of Improved Planting Material Trials

HYBRID VARIETY TRIAL

Object.—To observe and compare the performance of common sisal with eight promising hybrids received from Mlingano Experimental Station, Ngomeni, Tanganyika Territory.

Date of Commencement.—7th April, 1952.

Treatments.—Eight hybrids obtained from Mlingano Experimental Station, Tanganyika Territory, are compared with common sisal.

Spacing.—13 ft. $\times$ 3 ft. $\times$ 2 ft. 9 in.

Design.—3 $\times$ 3 balanced lattice. Nine treatments and four replications.

The last recording for growth in this trial took place in October, 1955, with the following results:—

			No. of leaves grown since planting	Length of last leaf in inches
<i>Agave sisalana</i>	..	..	128.0	41.9"
Hybrid No.—				
1155	..	..	156.1	28.0"
1269	..	..	213.2	31.3"
1300	..	..	181.6	35.9"
1317	..	..	228.1	32.3"
1475	..	..	176.0	35.1"
1660	..	..	212.8	35.9"
6964	..	..	214.5	34.3"
7131	..	..	213.3	28.8"

This trial will be cut in 1956 after which comparisons of fibre yield figures can be made. The hybrids will obviously produce a shorter fibre and it will be interesting to see whether the greater leaf number will make up in quantity what is lost in quality.

Up to now the increased rate of leaf production is clearly indicated, but as this is associated with a shorter leaf it is of small importance till yield figures are obtained. The total number of leaves at poling has got to be ascertained before a complete comparison can take place.

PLANT SELECTION TRIAL

Object.—To compare common sisal (*Agave sisalana*) with progeny of what has in some cases wrongly been termed "non-flowering" sisal.

Date of Commencement.—20th April, 1952.

Planting.—13 ft × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Design.—Six randomized blocks of five treatments.

The results from the recording of plant growth done in October, 1955, are as follows:—

Treatments	Average No. of leaves grown per plant	Average length of last unfurled leaf
From a so-called non-flowering plant No. 2 (Carver ex Juja) 3 suckers were collected. When they poled, bulbils were collected and the subsequent nursery plants are here marked—		
A	275.8	23.4"
B	265.1	23.9"
C	289.8	21.9"
Suckers from non-flowering plant No. 1 (Everard ex Donyo Sabuk) were planted and marked—		
D	229.8	31.7"
Common sisal is marked—		
E	131.7	53.8"
Difference required for significance—		
P=0.05	11.99	3.43
P=0.01	16.36	4.67

The trial had a first cut in September, 1955, and the fibre extraction for A, B and C amounted to about $\frac{1}{2}$ ton per acre while D yielded the equivalent of 0.86 tons per acre in comparison to 1.2 tons for common sisal.

The fibre percentage in the selected plants was smaller than in common sisal and the short length of the leaves meant that in A, B and C between 450–500,000 leaves were needed per ton of fibre compared to 175–200,000 leaves for D and 75–100,000 for common sisal.

Unless the selected plants continue for a long period after common sisal has poled, and make up the shortfall in fibre yield, they would appear to be of small commercial value, as the fibre extracted does not appear to be of a superior quality.

Herbicide Trials

Couch Trial No. 2 planted and treated in May, 1951, was fully reported in the Annual Report for 1953. By "couch" is meant *Digitaria scalarum*.

An attempt was made in December, 1953, to combat the reinfestation of "couch" which was competing with the sisal, by repeating the original T.C.A. treatments of 10, 20 and 40 lb. per acre in 80 gallons of water. All vegetation was cut to ground level before this application.

A die-back of slight severity occurred on the sisal leaves after this application.

The vegetation has since then been cut and removed twice, but "couch" was allowed to creep from plot to plot and the trial is at present covered with a luxuriant growth of "couch" and other grasses. This has hindered the rapid development of the plants which now, at $4\frac{1}{2}$ years, are very backward.

The differences in growth rates are still apparent and must be attributed to the initial boost that plants got in "couch"-controlled land rather than to the second attempt made to combat "couch" in the growing sisal.

The leaf count and leaf length for November, 1955, are as follows:—

				Leaf count	Leaf length
Control	..	..	..	85	30.1"
10 lb. T.C.A.	..	..	..	106	36.1"
20 lb. T.C.A.	..	..	..	111	36.7"
40 lb. T.C.A.	..	..	..	121	39.2"
P=0.05	..	..	..	11	3.26

This trial will not be continued for further observation.

Couch Trial No. 4, treated and planted in May, 1952 which also was reported on in the Annual Report for 1953 will be discontinued as no more results can be obtained from it.

This trial was also given a second treatment in December, 1953, at rates similar to the initial pre-emergent and pre-planting treatments of 10 and 30 lb. T.C.A. in 20 and 80 gallons of water per acre, but is at present smothered in "couch" as "couch" creeps from untreated to treated plots. A slight die-back also occurred in this trial after the second application of T.C.A.

The growth rates recorded in October, 1955, are as follows:—

T.C.A. application

T.C.A. per acre	10 lb.		30 lb.		Control	
	20 gal.	80 gal.	20 gal.	80 gal.	P=0.05	
Leaf length	30.6"	31.4"	35.0"	36.4"	28.1"	4.61"
Leaf count	100	103	118	121	95	12

The variations must be attributed to the first spraying which initially gave the plants the "couch"-controlled land to grow in so important for rapid growth in the early stages.

COUCH TRIAL NO. 5

Object.—To compare the effect on "couch" of heavy pre-emergent dressing of T.C.A. with lighter pre-emergent and post-emergent dressings.

Co-operator.—Messrs. Plant Protection Limited.

Date of Commencement.—Sisal planted 21st April, 1954.

Treatments.—All in 80 gallons of water per acre

	Pre-emergent 7/4/54	Post-emergent 23/11/54	3-5-55
1 ..	80 lb. T.C.A. per acre	Nil	Nil
2 ..	50 lb. T.C.A. per acre	35 lb. T.C.A. per acre	15
3 ..	50 lb. T.C.A. per acre	20 lb. T.C.A. per acre	18
4 ..	35 lb. T.C.A. per acre	35 lb. T.C.A. per acre	16
5 ..	35 lb. T.C.A. per acre	20 lb. T.C.A. per acre	19
6 ..	20 lb. T.C.A. per acre	20 lb. T.C.A. per acre	17
7 ..	Nil	Nil	Nil

Design.—7 x 7 Latin square.

The plots are graded according to the incidence of "couch" by scoring 0 for clean to 10 for a complete "couch" cover. The scorings are given below to show the influence of the second and third sprayings.

Treatments	1	2	3	4	5	6	7
Scoring for "couch"—							
26-8-54 ..	1.9	2.7	2.4	4.6	3.6	5.1	10.0
3-5-55 ..	4.1	1.3	2.0	2.0	2.6	3.7	9.1
20-1-56 ..	6.3	2.3	1.4	2.6	3.1	4.3	9.9

It would appear from the last assessment that treatment 6 with three sprayings each of 20 lb. T.C.A. per acre has given a better control of "couch" grass than 80 lb. T.C.A. per acre applied in one spraying initially. The best results in control of "couch" to date have been in treatment 3 with an initial spraying of 50 lb. T.C.A. per acre followed by two further sprays of 20 lb. T.C.A. per acre. The control of "couch" lasted for about 21 months.

After the second application, which took place on growing sisal seven months old, the sisal leaves developed a tip die-back and in some plants a tightening of the leaves in the central spike became noticeable and the leaves had difficulty in unfolding. When some of the new leaves broke away, parts of the tops of the central growing area were stuck together and the pressure of growth from below forced the central spike into a loop.

The scoring for phytotoxicity was done as follows:—

- (0) No abnormal growth symptoms.
- (1) Slight tip die-back.
- (2) Quite severe tip die-back.
- (3) Severe tip die-back and slight distortion.
- (4) Severe tip die-back and severe distortion.

The scores for the various treatments were as follows:—

	1	2	3	4	5	6	7
160 days after planting	0·4	3·3	2·1	3·1	2·1	2·0	0·4
262 days after planting	0·6	3·6	3·0	4·0	3·3	2·9	0·1

It is clearly shown how the pre-emergent spraying has had little adverse effect on the growth of sisal while the relation between heavier post-planting sprayings with more severe phytotoxicity is borne out.

COUCH AND WEED TRIAL

Object.—To study the effects of adding Methoxone, PCP and a wetting agent to T.C.A. in pre-emergent spraying.

Co-operator.—Messrs. Plant Protection Limited.

Date of Commencement

Spraying 12th April, 1954.

Sisal planted 21st April, 1954.

Treatments.—All in 80 gallons of water per acre:—

- (1) 50 lb. T.C.A. per acre.
- (2) 30 lb. T.C.A. per acre.
- (3) 30 lb. T.C.A. + 5 pints Agroxone 4 per acre.
- (4) 30 lb. T.C.A. + 3½ gallons Kanex + 4½ gallons diesel oil per acre.
- (5) 50 lb. T.C.A. + 8 fluid oz. "Agral" L N per acre.
- (6) Control.

Design.—Four randomized blocks of six treatments.

There was no application of T.C.A. in this trial after the sisal was planted and no leaf die-back or leaf distortions have occurred. The only treatment which is clearly beneficial to the growth of sisal appears to be the pre-planting application of T.C.A.

The rate of growth of the sisal planted is expressed as follows at the recording for October, 1955:—

Treatment	1	2	3	4	5	6	P=0.05
Leaf count	39	35	36	35	34	26	5
Leaf length	25.5"	24.4"	25.4"	25.6"	23.9"	22.3"	2.25

The "couch" is coming back in all areas but the initial control achieved is clearly demonstrated in the increased number of leaves produced per plant in the treated plots. Records are being kept to ascertain whether the plants will be able to maintain this initial advantage after the "couch" not killed by spraying has been allowed to grow.

OBSERVATION PLOTS WITH HERBICIDES

Small observation plots have shown that Maleic Hydrazide at 4, 8 and 16 lb. per acre, CMU at 2½, 5, 10, 20, and 40 lb. per acre, PCP (in oil) at 3, 6 and 9 pints per acre and PDU at 5, 10, 20 and 40 lb. per acre all in 100 gallons of water had no effect on sisal and only a negligible effect, if any, on "couch" and grass.

Dalapon applied at rates of 20 per cent of the T.C.A. applications showed promise as a "couch" killer, but when applied to land near growing sisal or applied as a spray over the sisal the results are a serious die-back of the leaves, the sisal getting progressively worse as the rates of applications get higher.

K. LERCHE,
Senior Assistant Agricultural Officer (Sisal).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), NYANZA PROVINCE, 1955

Weather

RAINFALL AT EXPERIMENTAL STATIONS, 1955 (INCHES)

	Kakamega	Bungoma	Kisumu	Kibos	Miwani	Kisii	Homa Bay	Sotik	Sotik Post
January	2.92	3.41	3.49	3.41	2.03	2.14	0.61	3.77	1.35
February	4.79	0.94	2.87	3.99	3.28	3.69	0.97	6.90	2.97
March	3.57	3.24	3.16	5.48	4.99	4.24	2.34	2.71	2.28
April	11.85	6.23	2.55	5.85	7.16	11.21	11.94	5.53	4.22
May	10.00	7.37	4.40	6.41	4.89	12.28	5.41	3.66	4.00
June	8.40	4.60	0.97	1.73	2.24	3.70	4.33	2.07	1.95
July	12.30	4.25	5.86	4.41	5.21	4.22	4.34	2.35	5.95
August	8.05	6.47	4.38	3.72	5.58	5.87	3.12	6.26	4.18
September	10.60	6.66	3.26	3.85	3.45	11.59	6.29	4.38	4.70
October	6.30	6.45	0.23	2.68	3.49	5.18	1.51	3.40	4.15
November	3.85	3.22	2.35	2.03	3.15	8.83	3.62	2.54	1.75
December	7.60	1.66	7.30	6.88	8.03	6.77	2.20	5.53	6.17
Total	90.23	54.50	40.82	50.44	53.50	79.72	46.68	49.13	43.67

In general rainfall distribution was more even than in 1954, crops were adversely affected in many areas in the Province by an unseasonal drought from March to May and extending into June on the Kano Plains.

Freak storms in April and May caused excessive wash on newly laid down trials at Kakamega, Kisii and Homa Bay and to one rotational field at Sotik.

The year has ended in very heavy storms all over the Province and has affected stored grain crops and caused further wash on land from which the standing crop had just been removed.

Reports on Experiments

COFFEE VARIETY TRIAL, KISII

This full scale trial was planted in 1950 to test 7 varieties of Arabica coffee in a 7 × 7 Latin square with nine trees per plot at 9 ft. × 9 ft. spacing on mulched box ridges. Yields were recorded for the first time in 1954 (*see* 1954 report). Yields for the 1955 crop are given below in cwts. per acre of parchment.

Variety	Cwt. per acre parchment
S.L. 28	4.10
Kents	3.51
Blue Mountain	3.49
Thorolds	2.99
Kenya Selected	2.77
S.L. 14	2.71
Kitale 145	2.44
Mean	3.14
Least significant difference (at P=0.05)	1.62

The general level of yield was much lower than in 1954-55, this may be due to the extremes of weather conditions encountered during the flowering period.

A very arbitrary scoring for *Hemileia* leaf rust was done during August, as in 1954 the varieties Kents, Thorolds and Kenya Selected were shown significantly to be less affected by rust than other varieties.

COFFEE MICROPLOT EXPLORATORY TRIALS

Many small varietal trials have been laid down in sites where there is a possibility that coffee may become a useful cash crop, these trials are generally 6×6 , 7×7 or 9×9 Latin squares with a single tree of each variety per plot. The number and location of these trials are as follows:—

North Nyanza, 24 in Southern and Elgon areas.

Central Nyanza, 5.

South Nyanza, 46.

Kericho (AA), 9.

There are also very small observational trials at low altitudes with Robusta coffee, none of which are in bearing yet.

Results of the great majority of these microplot trials are not yet to hand, but will be the subject of a separate report to the Coffee Research Station.

DRAINAGE AND PHOSPHATE TRIALS ON VLEI SOILS

At Sotik Post a trial was laid down to test 8 drainage treatments and phosphate application on plans submitted by the Senior Soil Conservation Engineer. All treatments were sown to Sabanero wheat and were split for double superphosphate at 100 lb. per acre versus nil. Treatment and yield figures were as follows:—

Plots receiving free flow of water from higher land

	lb. grain/acre
A—Ridge and Furrow (1 per cent slope) with phosphate ..	340
B—Ridge and Furrow (1 per cent slope) no phosphate ..	240
C—Flat with phosphate	400
D—Flat with no phosphate	320

Plots protected on upper side by a bank and cut-off drain

	lb. grain/acre
E—Ridge and Furrow (1 per cent slope) with phosphate ..	120
F—Ridge and Furrow (1 per cent slope) no phosphate ..	280
G—Flat with phosphate	340
H—Flat with no phosphate	280

Yield figures were obtained by taking 1/40 acre sample plots in each treatment. Harvesting was difficult as the crop was badly laid by a storm. Unfortunately at no time during the year was the vlei flooded to anything like its normal condition, so that the drainage treatments never played their full part.

At Kaptarongei Estate, East Sotik, a large scale drainage trial of 16 acres was laid down on typical vlei land. The treatments were herring-bone drains, versus ridge and furrow, versus flat, and with phosphate versus nil. The drainage treatments were laid down in late 1954, but due to very heavy out-of-season rains at the beginning of 1955 the area became water logged and unworkable at a time when ploughing preparatory to sowing should have been undertaken. Weed growth at this time was intense. The trial was eventually planted in June after further vicissitudes, each treatment being planted to Wheat, Oats, Barley, Maize

and Nandi *Setaria*. In a very short time all crops became swamped by weed growth and had to compete by themselves as labour for weeding was not available. From observations made during crop growth it would appear that the ridge and furrow was the most successful treatment and that the effect of phosphate was beneficial. Yield figures indicate nothing due to the hazards undergone; not only weather and weeds but wild game and bird damage as well. The trial will continue in 1956 under more favourable conditions as a tractor has been purchased to cope with extension experiments in Sotik and funds have also been provided for labour and watchmen.

EXPLORATORY FERTILIZER TRIALS

Only two exploratory trials were laid down this year (a) at Sotik Post and (b) at Cheleget in the Masai grassland zone. The Cheleget trial was destroyed due to the mid-season drought. Both trials, however, were scored in June just before the drought. At Cheleget there was a definite visual response to both farmyard manure at 5 tons per acre and phosphate at 1 cwt. per acre, but none to sulphate of ammonia applied 4-6 weeks after planting at 1 cwt. per acre. Plot size was the usual 1/80 acre.

The Sotik Post trial was brought to a successful conclusion and the results are given below expressed as bags (200 lb.) dry maize grain per acre:—

FARMYARD MANURE		DOUBLE SUPERPHOSPHATE		SULPHATE OF AMMONIA	
With	Without	With	Without	With	Without
23.28	20.40	22.74	20.94	22.14	21.54

These figures indicate a good response to both farmyard manure and to double superphosphate, with little response to sulphate of ammonia, and bear out the figures at scoring time earlier in the season.

FERTILIZER RATES TRIALS

One new fertilizer rates of application trial was started at Sotik Experimental Station during 1955. Double superphosphate and sulphate of ammonia were applied to maize, each at four rates of application; namely nil, 0.48 cwt., 0.96 cwt., and 1.44 cwt. per acre. The phosphate was applied in the planting lines just prior to planting and the sulphate of ammonia was applied in a band above each row at about six weeks after planting. The design was a 4×4 factorial with 32 plots of 1/80 acre each.

Yield figures are given below in bags (200 lb.) dry maize grain per acre:—

DOUBLE SUPERPHOSPHATE		SULPHATE OF AMMONIA	
Rate	Yield	Rate	Yield
<i>cwt.</i>		<i>cwt.</i>	
1.44	24.96	1.44	22.98
0.96	25.80	0.96	24.42
0.48	23.97	0.48	21.60
Nil	18.18	Nil	23.91
Mean ..	23.23	Mean ..	23.23
Least significant difference			
P=0.05 ..	4.43		4.43
P=0.01 ..	6.18		6.18

There was a good response to phosphate at all levels, but response seems to have reached a maximum at the 0.96 cwt. per acre level. There was no response to sulphate of ammonia and no interaction between the two fertilizers.

The fertilizer rates residual trial at Kisii had to be abandoned in 1955: due to a misunderstanding the pegs were removed and a disc plough taken through the experiment.

FARMYARD MANURE, METHOD OF APPLICATION

A new trial was started at Sotik Experimental Station to compare the application of 9 tons of farmyard manure per acre once in every three years, with the application of 3 tons of farmyard manure per acre in each year, to a series of arable crops the rotation being potatoes, maize, wheat. This is a long-term trial and results will not be available for some years.

TIE-RIDING TRIAL, HOMA BAY

This experiment was completed this year after its fourth crop and has now gone down to grass. Results of the trials of previous seasons are to be found in the Annual Reports from 1952 onwards.

In 1955 the trial was put down to maize and the table below shows the yields of dry maize grain in bags (200 lb.) per acre for the three cultivation treatments.

Bags (200 lb.) dry maize grain per acre

Treatment	Yield
3 ft. tie-ridging	7.53
5 ft. tie-ridging	7.08
Flat cultivation	7.21
Mean	7.27
Least significant difference ($P=0.05$)	0.16

3 ft. tie-ridging is not really significantly better than the other treatments as no significance was indicated in the 'F' test in the analysis of variance.

From past results of this experiment it is indicated that in general the practice of putting up 3 ft. tie-ridges gives higher yields than either 5 ft. tie-ridges or flat cultivation at Homa Bay.

FARMYARD MANURE AND PHOSPHATE TRIAL

This trial which started at Kakamega and at Kisii in 1952 was continued in the long rains 1955 at both stations with maize as the crop. The design was 3×3 factorial and the following treatments were reapplied this year at both stations:—

- Farmyard manure at nil, $2\frac{1}{2}$ and 10 tons per acre.
- Double superphosphate at nil, $\frac{1}{2}$ cwt. and 1 cwt. per acre.

At Kakamega a significant increase in yield of dry grain was obtained from the 10-ton dressing of manure as against control. Phosphate application failed to reach significance level and there were no significant interactions.

Kakamega, Long Rains, 1955: bags dry maize grain/acre

Farmyard Manure	Yield	Double superphosphate	Yield
10 tons/acre	13.95	1 cwt./acre	13.03
2½ tons/acre	13.18	½ cwt./acre	13.56
Nil	11.26	Nil	11.80
Mean	12.79		12.79
Least significant difference:			
(P=0.05)	1.94		1.94
(P=0.01)	2.64		2.64

At Kisii there were no significant differences between any of the treatments, but small increases were obtained with increasing rates of application of both fertilizers.

Kisii, Long Rains 1955, bags dry maize grain/acre

Farmyard Manure	Yield	Double superphosphate	Yield
10 tons/acre	14.67	1 cwt./acre	14.26
2½ tons/acre	13.46	½ cwt./acre	13.86
Nil	13.27	Nil	13.28
Mean	13.80		13.80
Least significant difference:			
(P=0.05)	1.63		1.63

FODDER CROP OBSERVATION PLOTS

The plots, which were originally planted in 1954 in the principal ecological zones of the Province, were continued in 1955. Cuts were taken as far as possible whenever the optimum fodder stage was reached. At Kisii, Kakamega and Sotik new plots of fodder beet, kale, sweet lupins and *Setaria splendida* were laid down to test their response to farmyard manure, phosphate and sulphate of ammonia. The following summarizes the results for the year:—

Napier grass, as in previous years, has given much higher yields than other fodder grasses, at Paponditi on poor soil and under dry conditions yields are low. Residual responses to fertilizers, particularly FYM have been obtained at Kisii to dressings applied in 1954. At Kakamega there appears to be no further response to any of the 1954 dressings. At Sotik a large phosphate response is evident on a site where Napier grass has been planted alone and in conjunction with two varieties of *Dolichos*, the *Dolichos* in these plots is very slow to recover from cutting and there is a possibility that it may disappear in its second year as has happened at a great many sites recently.

Improved perennial Kavirondo sorghum has been abandoned at most stations. The plant has become stemmy, with very little leaf, on the Kano plains it was droughted out and never showed any sign of being able to cope with lack of moisture.

Fodder Cane MF.2/40 has also been disappointing at most sites, its yield in no way compares with that of Napier grass and it takes a good deal longer to recover after cutting; on all stations responses to 1954 applied fertilizers and F.Y.M. have levelled off.

Sugar cane CO.421 has been tried as a fodder at Kakamega and Kisii: at both stations it appears to be intermediate between MF.2/40 and Napier grass, responses to F.Y.M., phosphate and nitrogen have been obtained at both sites. CO.421 seems to stand up to regular cutting better than MF.2/40.

Beckeropsis uniseta is indigenous at Kakamega and has done well and is palatable when cut at the correct stage, even so its yield is only about half that of Napier grass. At Kisii the yields of this grass are very low.

Setaria splendida was planted from splits at Kakamega, Kisii, Sotik and on the Kano plains. At Sotik it was droughted out shortly after planting. At Kakamega the first two cuts showed great promise but later in the year yields fell off alarmingly. At Kisii yields have been good and the usual large phosphate response was apparent. On the Kano plains there has only been one cut from Rabour and Ahero, the Paponditi plot being droughted before the splits had taken root.

Fodder beets were tried at main stations and at Sotik Post. In general yields were low at Kakamega, Kisii and at Sotik where a form of crown rot affected nearly every plant. At Sotik Post, however, root crops did very well, particularly a plot of mango'ds.

Kale was tried at various sites and it was evident that protection from caterpillar attack was a limiting factor.

Dolichos ex-Kilima Kiu. It has now become evident that much more experimentation needs to be done on this legume if it is to be included in a mixture with Napier grass. At almost every site where it has been tried it has succumbed after 12 months cutting; this may be due to mutual root competition. Trials are now being carried out with Napier at much wider spacings than the former 3 ft.

LEY SPECIES OBSERVATION PLOTS

These small plots, which were planted and fully reported on in 1954, continued, with regular yield cuts throughout the year. At Kisii and Kakamega the plots with treatments of F.Y.M. phosphate and nitrogen were continued, similar plots at Bungoma were abandoned early in the year due to the rapid encroachment of grass weeds. Yield figures have now been prepared for cuts taken at the grazing stage for one year and the following observations are worthy of note.

At Kakamega, Kisii and at Sotik establishment of seeded grasses is quite simple and the highest yields during their first year were obtained from Nandi *Setaria* and Nzoia Rhodes in these areas of higher rainfall. Molasses grass does not seem to persist at Kakamega or Kisii where there is a great deal of competition from the indigenous star grass and couch, at Sotik it persists a little better but it remains to be seen whether or not it will be overcome by Kikuyu grass.

At Homa Bay and in the Lambwe Valley, seeded grasses are most difficult to establish. For the first time on record Nzoia Rhodes was established under a maize nurse crop at Homa Bay this year, but 3 other seeded grasses failed and these blocks had to be vegetatively planted to Star grass, *Brachiaria brizantha* and *Panicum makarikariensis*, all of which have shown promise there.

At the 3 sites on the Kano Plains results have varied considerably, Ahero, being the least desiccated of the three, produced fair yields of Nandi *Setaria*, Nzoia Rhodes and *Cenchrus ciliaris*. At Rabour and Paponditi, Nandi *Setaria* had to be abandoned. Paponditi has shown most disappointing results with all seeded grasses, only *Panicum makarikariensis* has shown up at all favourably. Rongai Rhodes has done particularly well at Rabour as has *Panicum markarikariensis*. *Cenchrus ciliaris* and Nzoia Rhodes also show promise here.

Grass/legume grid trials were laid down at Kakamega, Sotik, Kisii and Sotik Post during the long rains. At Kakamega and Kisii grasses sown were Nandi *Setaria*, Nzoia Rhodes, Star, and *Paspalum dilatatum*: at Kisii a heavy storm shortly after sowing caused a great deal of wash thereby destroying the trial. The Kakamega grid is under close observation and Nandi *Setaria* and Nzoia Rhodes have done very well. *P. dilatatum* is sparse and is slowly succumbing to weed grasses. The legumes, which are *Trifolium semipilosum*, *Medicago denticulata*, *T. rueppellianum* and lucerne have all shown up well and it remains to be seen whether the annuals will appear once more in 1956. Weed growth in the lucerne strip necessitated its being hand weeded in the early stages. *T. semipilosum* when sown at 4 lb. per acre formed a solid carpet and proved unpalatable compared with the other legumes. At Sotik, Rongai Rhodes and molasses were included in the grid. The former was very poor and obviously out of its element, legumes except lucerne did well—*T. rueppellianum* and *M. denticulata* showed great promise particularly in association with molasses grass and Nandi *Setaria*.

At Sotik Post where a similar grid was planted with and without phosphate, the phosphate treated plots germinated more quickly in the first instance, but little difference was apparent after 3 months.

Yield cuts from the Cheleget plots showed that *Cenchrus ciliaris* and Rongai Rhodes were the most productive grasses in their second year. Nandi *Setaria*, which did well in its first year, produced very little in 1955.

GROUNDNUT VARIETY TRIALS, KIBOS AND HOMA BAY

The trial at Kibos had to be abandoned at the beginning of the season due to waterlogging. The Homa Bay trial of selected varieties from the Kibos collection was brought to a successful conclusion. No leaf spot or rosette disease was observed at any time. The design was in four randomized blocks. Plot size 1/193 acre. Spacing was 3 ft. × 2 ft. on 3 ft. tied ridges. The variety U/A-32=S.720 and the Homa Bay Farm Variety outyielded most other types. Varietal yields and their time to maturity are given below:—

Variety	Dry unshelled nuts lb. per acre	Days to maturity
U/A-32=S.720	2,855.6	164
Homa Bay Farm Variety	2,665.9	164
Nyanza local (Njugu Machon)	2,491.6	164
SA/A/1=A.H.32	2,158.6	151
SA/A-5=42-G-105	2,148.9	175
Nyanza local (Valencia Bunch)	2,067.6	151
SA/A-2=Masambika	2,027.0	151
U/A-8=B.688	1,713.3	151
Mean	2,269.8	
L.S.D. at P=0.05	673.7	
L.S.D. at P=0.01	916.6	

POTATO VARIETY TRIAL, KISII

This trial was carried out in the short rains 1954 as a repeat of the trial completed in the long rains of that year. The design was a 6×6 Latin square with plot size of 1/90 acre. Spacing was 2½ ft. ridges with 15 in. between plants

on each ridge. Growing period was from 9th October, 1954, until 24th February, 1955. Rainfall was quite well distributed during the experiment except in November. The variety D.49 was slow to germinate. Very little blight was seen and what there was seemed to be confined to the local type, as in the long rains trial. In general results were similar to the earlier experiment, Dutch Robyjin and A.49 outyielding most other varieties:—

Yields of fresh tubers

Variety	* Tons per acre
Dutch Robyjin	2.74
A.49	2.47
Kerr's Pink	2.22
Local Nyangusu	2.17
M.49	1.49
D.49	1.42
Mean.. .. .	2.09
L.S.D. P=0.05	0.62
L.S.D. P=0.01	0.71

TOMATO VARIETY TRIAL, BUNGOMA

Ten varieties were tested in six randomized blocks, each plot was a single row of 16 plants 3 ft. apart in the row. Rows were 6 ft. apart, mature plants were not staked. Sown in September 1954 the trial was harvested during January/early February 1955. The varieties Certified Early Red and Genovese outyielded significantly all other varieties.

There was some difference of opinion as to the quality of the fruit as the trial was harvested in the absence on leave of the European officer. Yield figures in tons per acre are given below:—

Variety	Tons per acre
Certified Early Red.. .. .	2.48
Genovese	2.37
Bawley's Selection	1.69
Homestead	1.26
San Marzano	1.16
T X.28A, 9:1:3	1.10
Break O'Day	1.09
Early Baltimore	0.93
Tatinter	0.86
K Y 1	0.69
Mean.. .. .	1.36
L.S.D. P=0.05	0.69
L.S.D. P=0.01	0.91

RICE OBSERVATION PLOTS, NAMASARIA

Experimental work at Namasaria during 1955 was confined to an unreplicated fertilizer trial to compare applications of sulphate of ammonia at 2 cwt. per acre and double superphosphate at 4 cwt. per acre, versus nil. This observational trial

was laid down at the request of Sir Alexander Gibb & Partners Irrigation Survey, Kisumu. The design took the form of four plots each of 1/15 acre. The variety used was transplanted Shingo la Majani spaced at 9 in. $\times$ 9 in. and transplanted immediately after the plots were fertilized. Irrigation was sufficient throughout the experiment. Results were inconclusive and the yields of dry grain in bags (160 lb.) per acre are given below:—

Treatment				Yield (bags paddy/acre)
NP	..	..	..	30.56
P	..	..	..	23.25
N	..	..	..	24.93
O	..	..	..	30.00
Mean..	..	..	..	27.18

A further unofficial trial was laid down under "hanging swamp" conditions in the Amakura area of North Nyanza. The object was to test the yields of the varieties Sindano, Mbuyu and Bungala, the seed being broadcast, without transplanting and without controlled irrigation. The design was that of seven randomized blocks with three plots per block, plot size was 1/40 acre and seed sown broadcast at 200 lb. per acre. The trial was planted late in the rains on the 20th May, 1955 and this may account for the low yield, lack of irrigation was another controlling factor. Yield figures are given below in bags of paddy per acre.

Variety				Yield (bags/acre)
Bungala	..	..	..	8.96
Sindano	..	..	..	6.78
Mbuyu	..	..	..	6.14
Mean..	..	..	..	7.29
L.S.D. at P=0.05	..	..	..	1.77

SORGHUM VARIETY TRIAL, HOMA BAY

This trial (which was duplicated at Kibos but suffered firstly severe waterlogging and then severe drought on that station) was put down with the object of testing the yields of ten promising varieties obtained from the Kibos observation plots in 1954. The design was four randomized blocks with ten plots per block, plot size was 1/193.6 acres. Spacings were 3 ft. $\times$ 2 ft. on 3 ft. tied ridges. Planting took place on 30th April, 1955 and harvesting on 19th September, 1955. Observations were made on disease resistance, head density and grain colour, leafiness and time of maturity. The two varieties Dobbs and Dobbs ex-Kongwa significantly outyielded all other varieties. Dwarf Kano sorghum failed to germinate in any plot. Yield figures were:—

Variety	Yield (bags 200 lb./acre)
Dobbs ex Kongwa	8.58
Dobbs	6.65
Enyanza	4.95
S.U.K.I.	3.87
Homa Bay Farm Sorghum	3.74
Dwarf Shallu	2.78
B.C.27	2.66
Oklahoma	1.32
B.C.81	0.91
Dwarf Kano	Failed to germinate
Mean	3.94
L.S.D. (P=0.05)	2.24

SUGAR VARIETY TRIALS, MIWANI—KIBOS AREA

The trial at Kala Singh's farm has now been completed after the harvest of the second ratoon crop: the trial was planted in 1950, the plant cane crop came off in 1952, first ratoon harvest in April, 1954, and second ratoon in October, 1955.

Yield figures for the whole trial since commencement are shown below, figures are in tons of cane per acre:—

Variety	Plant Crop	1st ratoon	2nd ratoon	Total tons/acre
CO.331	58.76	33.42	51.09	143.27
CO.213	58.10	25.07	31.93	115.10
CO.434	45.29	28.23	36.52	110.04
B.3337	41.21	24.80	40.71	106.72
CO.419	48.10	19.41	36.79	104.30
CO.408	43.81	19.64	35.80	99.25
CO.285	40.91	19.35	35.95	96.21
CO.281	31.07	22.26	40.14	93.47
CO.421	41.72	18.93	30.93	91.58
CO.417	34.98	19.76	32.68	87.42
CO.432	38.34	16.25	26.82	81.41
MF.2/40	35.59	17.37	28.38	81.34
POJ.2747	26.96	15.95	29.41	72.32
CO.244	33.18	13.16	25.42	71.76
B.2257	22.17	11.15	24.15	57.47
POJ.2714	20.33	10.37	21.64	52.34
Mean	38.77	19.69	33.02	
L.S.D. (P=0.05)	20.04	5.63	4.19	

The large reduction in yield of the 1st ratoon compared to the plant crop was probably due to drought in the severe dry season of 1952-53: comparing the plant cane crop to the second ratoon the mean yield reduction is of the order of 8 per cent only. Although the presence of "Ratoon stunting disease" was confirmed in some of the varieties in 1954, this disease appears to have had little effect upon the second ratoon crop under adequate rainfall. It is also of interest to note that CO.331 and CO.213 produce the highest calculated yield of sucrose per acre of these 16 varieties.

The trial at Miwani of 5 varieties selected from the above 16 varieties has now gone through its 1st ratoon. The only figures available at present are those for the 5 × 5 Latin square planted on the upper red soil of the estate. A similar trial was planted at the same time on the lower black soil. Plot size was 1/24 acre and spacing 6 ft. × 2 ft. on 6-ft. ridges. Yields of cane are shown below:—

Miwani, 1st ratoon. Tons of cane per acre (upper red soil)

Variety				Yield
CO.331	..	..	..	31.45
CO.419	..	..	..	22.74
CO.421	..	..	..	22.44
CO.213	..	..	..	19.42
CO.408	..	..	..	19.07
Mean	..	..	..	23.02
L.S.D. (P=0.05)	..	..	..	3.45
L.S.D. (P=0.01)	..	..	..	4.84

CO.331 has outyielded significantly all other varieties and CO.419 has outyielded CO.408 significantly. In this 1st ratoon crop there were several changes in the order of precedence of varieties when compared to the plant cane crop as shown in the 1954 report, but CO.331 still appears the most successful variety. Reduction in yield from plant crop to 1st ratoon is approximately 8 per cent.

SUGAR CANE VARIETY TRIAL, MIWANI

This trial of 16 varieties had its plant crop harvest in January 1955, the design being 4 × 4 balanced lattice with plot size of 1/134.4 acres. Spacing was 6 ft. × 2 ft. on 6-ft. ridges. Plantings took place in March, 1953, on the sandy red loam which is typical of the upper part of the estate.

Yields of cane are shown below together with the sucrose yield (calculated) in tons per acre.

Variety				Yield of cane (tons/acre)	Sucrose yield (tons/acre)
CO.411	..	..	..	52.80	4.78
NCO.291	..	..	..	49.01	5.13
CO.453	..	..	..	47.82	5.52
B.37193	..	..	..	47.75	4.45
B.41227	..	..	..	41.64	4.01
POJ.2961	..	..	..	40.52	4.67
NCO.79	..	..	..	40.28	5.26
CO.290	..	..	..	39.66	3.54
CO.421	..	..	..	39.39	3.58
CO.281	..	..	..	37.94	4.84
NCO.330	..	..	..	36.68	3.94
B.3337	..	..	..	34.68	3.63
C.P.36/105	..	..	..	29.99	3.07
B.3257	..	..	..	29.22	3.54
C.P.34/120	..	..	..	22.77	2.24
C.P.34/79	..	..	..	12.06	1.29
Mean	..	..	..	37.64	3.97
L.S.D. (P=0.05)	..	..	..	8.52	
L.S.D. (P=0.01)	..	..	..	11.21	

SUGAR CANE VARIETY TRIAL, KAKAMEGA

The plant cane crop was harvested in 1953 and results are reported in the Annual Report for that year. The trial is of 8 varieties and is laid out in 4 randomized blocks, with a plot size of 1/60 acre and spacing of 6 ft. × 3 ft. on the flat. The first ratoon crop was taken in March 1955. B.3337 and CO.421 have given practically the same yields of both cane and sucrose and have very significantly outyielded all other varieties in the trial. The general level of yield is very satisfactory for a ratoon crop and is not much less than the yield obtained in the plant cane crop.

Yields of cane and of sucrose in tons per acre are given below:—

Variety	Cane yield (tons/acre)	Sucrose yield (tons/acre)
B.3337	58.29	6.26
CO.421	58.02	6.43
CO.417	46.48	4.48
P.R.803	31.45	3.65
Mayaguez 49	27.81	3.77
POJ.2725	23.04	3.20
B3172	22.88	3.17
POJ.2714	13.21	1.80
Mean	35.15	4.10
L.S.D. (P=0.05)	7.53	
L.S.D. (P=0.01)	10.26	

MOLASSES AND FILTER PRESS MUD EXPERIMENT ON SUGAR CANE, MIWANI

The object was to test the effect on yield of sugar cane of two factory by-products, molasses and filter press mud, each in combination with sulphate of ammonia at three rates of application. Design was six randomized blocks of nine treatments. Plot size 1/20 acre. Cane variety CO.421. The experiment was planted in May, 1953, and sulphate of ammonia applied at that time, but the molasses and filter press mud had been applied in the short rains of 1952, the delay in planting was caused by unfavourable weather conditions after the application of filter press mud. The plant cane crop was taken in April, 1955. Treatments were:—

Sulphate of ammonia:—

at 6 cwt. per acre.

at 3 cwt. per acre.

Nil.

Filter press mud:—

at 1 ton per acre.

Molasses:—

at 1½ tons per acre.

There was no significant difference between treatments at the 5 per cent level but the figures suggest a possible small response to filter press mud and to sulphate of ammonia at 3 cwt. per acre, but no response and perhaps a depression

in yield from the 6 cwt. per acre sulphate of ammonia treatment. There was no apparent response to molasses. Yield figures in tons of cane per acre are given below:—

Yield of Cane: tons per acre						Mean
NO ..	30.68	No M	32.76	No F ..	32.56	32.00
N3 ..	33.29	N3 M	31.91	N3 F ..	33.41	32.81
N6 ..	29.83	N6 M	29.93	N6 F ..	29.64	29.80
Mean ..	31.27		31.53		31.87	31.56

KEY:

N=Sulphate of ammonia.

F=Filter press mud.

M=Molasses.

SUGAR CANE SPACING EXPERIMENT, CHEMELIL

The object has been to study three different row spacings, 4 ft., 5 ft. and 6 ft. on the yield of cane. The design was that of randomized blocks with five replications. The second ratoon crop was harvested in March, 1955, and the trial has now been concluded. At the plant cane harvest in 1951 there were no significant differences in yields at the three different spacings; in the first ratoon taken in June, 1953, there were again no significant differences although there was a tendency for the two closer spacings to yield slightly more. The second ratoon crop again produced no significance, but on this occasion there was a tendency for the two wider spacings to yield more heavily. Cane variety was CO.281.

It is now considered that as there is so very little difference in yield between treatments, the 6 ft. spacing is preferable in that it is most suitable for mechanical cultivation in estates.

Yield figures are given below for the three crop harvests:—

Mean Yields: Tons Cane per Acre

Spacing				Plant Crop	First Ratoon	Second Ratoon
4 ft. rows	..	..	..	40.72	19.41	15.46
5 ft. rows	..	..	..	41.35	19.40	17.38
6 ft. rows	..	..	..	41.51	18.75	17.10

HERBICIDE TRIAL IN SUGAR CANE, MIWANI

As a result of an earlier trial which had shown good dicot. weed control by pre-emergent M.C.P.A. and good grass weed control by T.C.A., an experiment was laid down in August 1953 to test these in combination. All herbicides were applied as a single pre-emergent treatment one week after planting the cane. No weeding whatever was done between planting and harvest so that weed control was dependent entirely upon the herbicide treatments. By the end of 1953 the experiment was heavily infested by a wide variety of weeds, but there was a great variation between treatments in the degree of infestation and this

variation persisted until the harvest of the cane in February 1955. A brief summary of treatments and visual observations follows:—

- (a) (Control). Cane almost completely smothered by thick mantle of *Convolvulus* sp. *Striga* abundant and in full flower, Couch, Star grass and sedge abundant.
- (b) (T.C.A.). Poor dicot. control, fair control of low growing grasses (Couch and Star) but not of the tall grasses (*Sorghum* sp. and *Rottbælia exaltata*).
- (c) (M.C.P.A.). Fair dicot. control, but poor control of all grasses.
- (d) (P.C.P.). Similar to (a) but less *Striga*.
- (e) (T.C.A. plus M.C.P.A.). Fair control of all weeds except sedges.
- (f) (M.C.P.A. plus P.C.P.). Fair dicot. control, grass control poor but better than (c).

Yields of Cane: Tons per Acre

Treatment						Yield
(e) (T.C.A. plus M.C.P.A.)	..	..	..	..	..	5.65
(b) (T.C.A.)	..	..	..	..	..	3.67
(f) (M.C.P.A. plus P.C.P.)	..	..	..	..	..	2.37
(c) (M.C.P.A.)	..	..	..	..	..	2.07
(d) (P.C.P.)	..	..	..	..	..	1.12
(a) (Control)	..	..	..	..	..	0.93
Mean	..	..	..	..	..	2.64
Least significant difference (P=0.05)	..	..	..	..	..	2.48

The level of yield is very low as no treatment was able to keep the cane free of weeds for long enough between planting and canopy formation.

The combination of T.C.A. and M.C.P.A. was the most successful treatment and resulted in a significantly higher yield of cane than all other treatments except that with T.C.A. alone.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), RIFT VALLEY PROVINCE, 1955

Introduction

In general the rainfall conditions over the Province have been unfavourable. In many cases the total rainfall has been average, but the distribution poor. A dry period followed planting from April until the beginning of June and the late rains further hampered cereal harvesting although they did help to fill out the maize crop.

Comparative rainfall figures for the various centres are as follows:—

	1953	1954	1955
Nakuru	27·89	42·80	37·58
Kitale	35·78	47·91	40·12
Eldoret	29·60	38·13	39·79
Oi Joro Orok	29·64	36·79	35·28
Njoro	24·27	46·48	38·92
Rongai	22·88	45·08	25·36

Experimental Work—Nakuru District

DRAINAGE

The experiment to determine the drainage requirements of vlei soils started in 1951 on a farm at Londiani (7,500 ft.) was continued in 1955. The treatments consisted of six plots moled and six plots unmoled. Both treatments were sown with 341 wheat at 75 lb./acre and received a basal dressing of 100 lb. double superphosphate per acre. Two combine widths from each plot were harvested.

In January, 1956, the moles were inspected by Mr. Barnes, Senior Soil Conservation Engineer. The moles were in remarkably good condition considering that the plots had been under crop for five years. Although some moles were beginning to cave in they were still effectively removing surface water.

During the growing season there was little visual difference between plots, but on harvesting the moled plots gave greater yields.

The summary of results is as follows.—

Trt. Mean	TREATMENTS		SIGNIFICANT DIFFERENCE	
	Moled	Unmoled	1 per cent	5 per cent
lb./plot	231·3	159·2	39·35	25·09
Bags/acre	6·24	4·30	1·06	0·68
% of Mean	118·4	81·5	20·15	12·84

Thus mole draining of this vlei soil increased yield significantly (1 per cent) by 1.94 bags per acre.

LEY ESTABLISHMENT

Four ley establishment trials have been laid down as follows:—

I. A ley establishment trial using Nandi *Setaria* was started at Njoro in 1954 and continued in 1955. The treatments were as follows:—

- (a) Grass drilled under wheat in 7-in. drills in 1954.
- (b) Grass drilled under wheat in 14-in. drills in 1954.
- (c) Grass drilled under oats in 14-in. drills in 1954.
- (d) Grass drilled in pure stand in 7-in. rows in 1954.
- (e) Grass drilled in pure stand in 7-in. rows in 1955 following pure wheat in 1954.

All plots were duplicated to compare a top dressing of $1\frac{1}{2}$ cwt. of ammonium sulphate per acre and no top dressing, giving three randomized blocks of ten plots. Seven grass cuts were taken throughout the year, but no differences between treatments of statistical significance were obtained, apart from the effect of top-dressing, the results of which are summarized as follows:—

Trt. Means	TREATMENTS		SIGNIFICANT DIFFERENCE	
	Top-dressing	No top-dressing	1 per cent	5 per cent
Ib./plot	348.1	117.6	40.9	29.8
Tons/acre	9.7	3.3	1.14	0.83
% of Mean	100.3	33.9	12.0	8.0

Thus top-dressing has given a significant (1 per cent) increase in yield of 3.4 tons per acre of green material.

II. A similar trial using Rongai Rhodes grass was started in 1954 at Rongai.

Again no differences of statistical significance occurred between under-sowing treatments, but top-dressing produced an increased yield of $\frac{1}{2}$ ton of green material per acre, which is significant at 5 per cent.

A summary of the results is as follows:—

Trt. Means	TREATMENTS		SIGNIFICANT DIFFERENCE	
	Top dressed	No Top dressing	1 per cent	5 per cent
Ib./plot	290.4	271.1	24.2	17.6
Tons/acre	8.1	7.6	0.68	0.49
% of Mean	10.4	96.5	8.6	6.3

III. A similar trial was started at Rongai in 1955, but with all plots receiving a top dressing of $1\frac{1}{2}$ cwt. sulphate of ammonia. Because of rat, bird and drought damage, no wheat was harvested, but an average yield of 257.6 lb./plot of oats was obtained.

The summary of the yield of grass is as follows:—

Trt. Means	TREATMENTS				SIG. DIFF.	
	Pure stand	Under 7" wheat	Under 14" wheat	Under oats	1 per cent	5 per cent
lb./plot ..	843	490	518·6	169·6	415·1	274·0
Tons/acre ..	23·5	13·7	14·5	4·7	11·6	7·6
% of Mean	166·6	97·1	102·8	33·3	82·1	54·2

Thus grass grown in pure stand has produced a significant response at 5 per cent of 9.0 tons per acre over grass sown under wheat in 14-in. drills. There is no significant difference between the yield of grass when sown under 14-in. wheat and 7-in. wheat. Grass sown under oats has given significantly lower yields than any other treatment.

IV. A further trial of similar design was started at Rongai in 1955 using *Panicum maximum* (Sigor Hairless). Again the wheat crop had to be abandoned due to damage by birds, rats, drought and weeds, so that no information on the reduction of the wheat crop due to undersowing is available. The summary of the grass yields is as follows:—

Trt. Means	TREATMENTS				SIG. DIFF.	
	Pure stand	Under 7" wheat	Under 14" wheat	Under oats	1 per cent	5 per cent
lb./plot ..	352·0	142·3	368·3	65·6	279·9	184·7
Tons/acre ..	9·8	3·9	10·3	1·8	7·8	5·1
% of Mean	151·7	61·3	158·7	28·3	120·6	79·6

Thus grass sown in pure stand has given a significantly greater yield than either that sown under 7-in. wheat or oats, but there is no significant difference between the latter two treatments.

Although the indications are that the grass yield is greater when undersown in 14-in. wheat there is no significant difference between that and grass sown in pure stand.

MAIZE

An experiment to determine the effect of nitrogen, row spacing, plant population and interplanting of a legume on the yield of maize was carried out on the Curtis farm at Kampi ya Moto. The design was a $4 \times 2 \times 2 \times 2$ confounded factorial with one replication embracing combinations of the following treatments:—The application of nitrogen was at the rate of 2 cwt./acre applied at planting time (N1), knee height (N2), or half at planting and half at knee height (N3), with a control plot (N0). The row spacing was 3 ft. 6 in. (S1) compared with 6 ft. 6 in. (S2) spacing. The plant population was 10,000 (P1) compared with 14,000 (P2) plants per acre. Half the plots had a legume (L) (sweet lupin) interplanted and half did not (—).

This trial suffered badly from drought and there were no visible differences between treatments. Statistical analysis showed that there had been a depression in yield by increasing the row spacing from 3 ft. 6 in. to 6 ft. 6 in. There was an indication, though not significant, that the higher plant population had responded more to nitrogen.

The summary of the results for main effects is as follows:—

Trt. Means	TREATMENT				SIG. DIFF.
	N0	N1	N2	N3	5 per cent
lb./plot ..	10.82	11.81	13.21	10.35	3.19
Bags/acre ..	1.77	1.94	2.17	1.70	0.51
% of Mean	93.7	102.2	114.4	89.6	27.6

Trt. Mean	TREATMENTS						SIG. DIFF.
	S1	S2	—	L	P1	P2	5 per cent
lb./plot ..	12.81	10.29	11.12	11.98	10.97	12.13	2.26
Bags/acre ..	2.10	1.69	1.87	1.96	1.79	1.99	0.37
% of Mean ..	110.9	89.1	96.3	101.7	94.9	105.0	19.6

ANIMAL HUSBANDRY

A lamb-fattening trial was conducted in 1955 on Scott's farm, Njoro, using 24 Corriedale lambs recently weaned, divided into three groups. One group received stubble grazing only (1), another group stubble grazing plus 1 lb. crushed oats per lamb per day (2) and the third group received stubble grazing, 1 lb. of oats and 1 lb. of lucerne hay per lamb per day (3).

A summary of the results is as follows:—

Trt. Means	TREATMENTS			SIG. DIFF.	
	1	2	3	1 per cent	5 per cent
Mean weight increase ..	18.7	20.6	24.0	2.47	1.78
% of Mean	88.5	97.5	113.6	11.7	8.4

The addition of 1 lb. of oats to the ration has increased the liveweight gain significantly (5 per cent) above the liveweight gain on stubble grazing only. The addition of 1 lb. of lucerne to the rations has produced liveweight gains significantly (1 per cent) higher than either of the other two treatments. However, in spite of significant liveweight increases, the increased cost of foodstuffs does not make the extra feeding economic.

Ol Joro Orok Experimental Farm

ENTOMOLOGY

A trial was carried out on the farm of W. H. Goddard, Esq., Ol Kalou, to compare the efficiency of Aldrin and Mergamma C. for the control of the Ol Kalou wheat beetle (*Hetronychus consimilis*). Both insecticides were applied to 337 wheat planted on 9th June, 1955. The treatments consisted of Aldrin (40 per cent wettable powder) applied at 4 oz. per 80 lb. of seed as a seed dressing, Mergamma C. at the same rate, and a control, all laid out as three randomized blocks of three plots of $\frac{1}{4}$ acre.

The summary of the results is as follows:—

Trt. Means	TREATMENTS			SIGNIFICANT DIFFERENCE	
	Aldrin	Mergamma C	Control	1 per cent	5 per cent
lb./plot ..	280.0	267.0	107.7	48.49	32.01
Bags/acre ..	5.60	5.30	2.15	0.97	0.64
% of Mean	128.2	122.3	49.3	22.2	14.6

Both treatments were substantially better than the control, but there was no significant difference between the two insecticides. Which is to be used will depend entirely on economics.

Eldoret Experimental Farm

FERTILIZERS

An experiment to test the residual and cumulative effects of various phosphate fertilizers, started in 1952, was continued in 1955.

The trial was laid down as a 10×10 Latin square to test the following treatments:—

- Uganda rock applied in the first and second years.
- Double supers in the first, second and third years.
- Double supers in first year only.
- Soda phosphate applied in the first and second years.
- Uganda rock applied in first year only.
- Double supers in first and second years.
- No phosphate—control plot.
- Soda phosphate applied in first year only.
- Uganda rock applied in first, second and third years.
- Soda phosphate applied in first, second and third years.

As a result of poor conditions at beginning of growing season, yields have been low.

The following is a summary of the 1955 results:—

Treatments

Trt. Means	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
lb./plot ..	3.82	6.68	3.87	4.95	3.00	5.65	1.84	3.70	5.28	6.15
Bags/acre	1.08	1.88	1.09	1.40	0.85	1.59	0.52	1.04	1.49	1.73
% of Mean	55.0	148.7	86.3	110.2	66.8	125.7	40.9	81.3	117.5	1.37

SIG. DIFF.

1 per cent	5 per cent
0.865	0.658
0.244	0.186
19.25	14.68

Coefficient of variation, 12.6 per cent.

Thus of the phosphate fertilizers applied over three years both double supers and soda phosphate have given a significantly (1 per cent) greater yield than Uganda rock and the control plot.

When applied during the first and second years only, double supers have given significantly greater yields than either soda phosphate or Uganda rock, but both double supers and soda phosphate are significantly (1 per cent) better than Uganda rock.

When applied in the first year only there is no significant difference between the yields produced by double supers or soda phosphate, but both produce significantly (5 per cent) higher yields than Uganda rock.

All treatments are superior to the control plot.

An experiment was started in 1952 and continued in 1955 to test the effect of varying amounts of N, P and K on barley, wheat and oats. This trial was laid out as a 3¹, with a single replication, to embrace combinations of the following treatments:—

- (1) Double super, 0, 75 and 150 lb./acre.
- (2) Sulphate of ammonia, 0, 100 and 200 lb./acre.
- (3) Muriate of potash (60 per cent), 0, 75 and 100 lb./acre.
- (4) Oats (Boone) at 70 lb./acre, wheat (294M) at 80 lb./acre and barley (Research) at 70 lb./acre, all in 8-in. rows.

Statistical analysis of the results showed that barley gave the highest yield, followed by wheat, then oats.

Increasing additions of phosphate have had significant results and the expression for phosphate is highly linear.

No other main effects are significant.

There is a highly significant interaction between crops and phosphate. The response of barley over the three levels of phosphate is greater namely 80.41 per cent than either wheat or oats, which are 58.40 per cent and 59.57 per cent respectively.

A summary of the significant main effects is as follows:—

Trt. Means	TREATMENTS			SIGNIFICANT DIFFERENCE	
	Wheat	Barley	Oats	1 per cent	5 per cent
lb./plot ..	14.86	50.50	3.55	4.14	3.15
Bags/acre ..	3.34	11.31	0.79	0.93	0.70
% of Mean	64.69	219.85	15.47	18.02	13.71

Trt. Means	SUPERPHOSPHATE			SIGNIFICANT DIFFERENCE	
	Nil	75 lb.	150 lb.	1 per cent	5 per cent
lb./plot ..	16.45	23.79	28.67	4.14	3.15
Bags/acre ..	6.68	5.33	6.42	0.93	0.70
% of Mean	71.62	103.57	124.81	18.02	13.71

Kitale Experimental Farm

FERTILIZERS

A phosphate fertilizer evaluation trial was laid down on Mr. Wilson's farm as a 7×7 Latin square to test the following treatments on the yield of maize:—

B—Control, no fertilizer.

G—.33 cwt./acre P_2O_5 as double supers.

E—.66 cwt./acre P_2O_5 as double supers.

A—.66 cwt./acre P_2O_5 as single supers.

C—.50 cwt./acre citric soluble P_2O_5 as soda phosphate.

F—.50 cwt./acre citric soluble P_2O_5 as basic slag.

D—.50 cwt./acre citric soluble P_2O_5 as North African rock phosphate.

North African rock phosphate gave the highest yield, but there is no significant difference between this and .66 cwt double supers, .50 cwt. soda phosphate or .33 cwt. double supers. There is no significant difference between .33 cwt. P_2O_5 as double supers and .50 cwt. P_2O_5 as basic slag, or between basic slag and .66 cwt. P_2O_5 as single supers. Other differences are significant and all treatments are better than control.

The following is a summary of the 1955 results:—

Means as		TREATMENTS							SIG. DIFF.	
		A	B	C	D	E	F	G		
lb./plot ..	..	89.3	86.3	98.3	100.3	99.7	92.6	95.8	6.0	5.0
Bags/acre ..	..	11.10	10.70	12.19	12.44	12.36	11.48	11.88	0.74	0.62
% of Mean	..	94.5	88.3	103.8	105.9	105.3	97.8	101.2	6.3	5.3

Coefficient of variation, 9.05 per cent.

MAIZE

An experiment to test the effect of row spacing, plant population, inter-planting of legume and time of nitrogen application on the yield of maize was laid down in 1955 as a 4×2^3 counfounded factorial with two replications, and the following treatments:—

Time of nitrogen application N0—Nil.

N1—2 cwt. at sowing time.

N2—2 cwt. at knee height.

N3—1 cwt. at sowing, 1 cwt. at knee height.

Row spacing S1— $3\frac{1}{2}$ ft.

S2—6 ft.

Plant population P1—10,000 plants per acre.

P2—14,000 plants per acre.

Legume —No legume.

L—Interplanted *Dolichos*, ex Kilima Kiu.

Of the nitrogen treatments, application at knee height has given the highest yield of 16.60 bags/acre which is significantly (1 per cent) higher than any other treatments. This is followed by half at knee height and half at planting time, followed by nitrogen at planting time and finally no nitrogen, which has given significantly lower yield than any other treatment.

Of the spacing treatments the 3 ft 6 in. spacing has given an average of 2.67 bags per acre more than the 6 ft. 6 in. spacing (significant at the 1 per cent level).

No other treatments or interactions have given significant responses. A summary of the pertinent yield data for 1955 is as follows:—

Means as	TREATMENTS				SIG. DIFF.	
	N0	N1	N2	N3	1 per cent	5 per cent
lb./plot ..	109.8	114.5	126.7	121.0	3.63	2.76
Bags/acre ..	14.38	14.99	16.60	152.85	0.475	0.365
% of Mean	93.05	97.03	107.37	102.54	3.08	2.26

Means as				SPACING TREATMENT		SIG. DIFF.	
				S1	S2	1 per cent	5 per cent
lb./plot				128.2	107.8	1.81	1.38
Bags/acre				16.79	14.12	0.237	0.181
% of Mean				108.64	91.36	1.53	1.17

WEEDS

A 3^3 counfounded factorial with a single replication was laid out to compare three levels of Agroxone 4 at 0 and .75 lb. and 1 lb. acid equivalent per acre sprayed at pre-emergence, the 2–3 leaf stage and at 8 in. high, early in the season at mid-season and late in the season.

Of the Agroxone treatments both .75 lb. and 1 lb. acid equivalent per acre have given significantly higher yields than control.

At 1 lb. acid equivalent per acre the Agroxone has decreased the yield of maize by 0.62 bags per acre compared with the application of 0.75 lb. acid equivalent per acre and the difference is significant at the 5 per cent level.

Early spraying has given the best result followed by mid-season spraying followed by late spraying. The increase in yield is 6.41 and 10.63 bags per acre respectively.

A summary of the pertinent yield data for 1955 is as follows:—

Trt. Mean as	AGROXONE TREATMENTS			SIG. DIFF.	
	0 lb.	0.75 lb.	1 lb.	1 per cent	5 per cent
lb./plot ..	63.55	77.44	72.44	7.52	4.96
Bags/acre ..	7.88	9.60	8.98	0.93	0.62
% of Mean	89.32	108.84	101.81	10.57	6.97

Trt. Means as	DATES OF SPRAYING			SIG. DIFF.	
	Early	Mid-season	Late	1 per cent	5 per cent
lb./plot ..	117.00	65.22	31.22	7.52	4.96
Bags/acre ..	14.50	8.09	3.87	0.93	0.62
% of Mean	164.44	91.66	43.88	10.57	6.97

Coefficient of variation, 12.84 per cent.

P. W. A. DAVIES,
*Agricultural Officer (Experiments),
 Rift Valley Province.*

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), CENTRAL PROVINCE, 1955

Rainfall

	MOLINDUKO		EMBU		MWEA	
	Inches	Days	Inches	Days	Inches	Days
January ..	1.09	5	1.08	6	Nil	Nil
February ..	1.44	4	1.53	4	1.62	6
March ..	0.23	4	1.11	5	1.41	6
April ..	5.67	13	9.22	21	7.43	15
May ..	6.95	14	10.60	23	3.49	12
June ..	0.20	2	1.06	9	0.02	1
July ..	0.22	2	0.63	12	0.05	1
August ..	Nil	Nil	0.30	9	Nil	Nil
September ..	Nil	Nil	0.63	8	2.39	2
October ..	2.43	9	3.11	14	2.03	7
November ..	4.23	11	4.41	16	2.81	10
December ..	1.43	8	1.87	8	2.31	9
Total ..	23.89		35.55		23.56	

Long rains rainfall started rather late and finished rather early. At Embu 5.27 ins. fell in one storm in May. At Molinduko 3.05 ins. fell in the same storm. Short rains were poor until the end of December.

Reports on Experimental Work

(1) HIGH BRACKEN ZONE

Grass species and exploratory manurial trial. This trial has been previously reported in 1954. It was started at Kianjokoma farm in 1953 in order to gain indications of the productivity of three grass species. Three manurial treatments were used on establishment. *Melinis minutiflora*, *Panicum maximum* and *Pennisetum clandestinum* were compared in combination with 5 tons per acre farmyard manure versus 2 cwt. per acre double superphosphate versus nil in two replications of a 3² factorial layout. There was no subsequent manuring. Samples totalling 22 square yards per plot were cut prior to each grazing. Whole plot size was 1/20 acre.

Two-way table of results.—Total treatment yields per acre 1953 to 1955 in tons of unwilted green material

	FYM	Phosphate	Nil	Mean
<i>Melinis</i>	49.35	45.71	40.61	45.22
<i>Panicum</i>	38.69	34.17	27.64	33.50
<i>Pennisetum</i>	51.12	43.16	38.35	44.19
	46.38	41.01	35.53	

L.S.D. at the 5 per cent level of t between two marginal means=9.80 tons.

The F test showed only that differences between grass treatments reached significance at PO.05.

In the first year, 1953, both *Melinis* and *Panicum* significantly outyielded *Pennisetum*. In 1954 *Melinis* significantly outyielded *Panicum* but the *Pennisetum* had started to catch up on the other grasses. In 1955 *Pennisetum* significantly outyielded both the other grasses. In 1953 *Melinis* with phosphate significantly outyielded unmanured *Melinis*. In the following year the response to the residual phosphate by this grass was significant at the 5 per cent level according to the *t* test but this was not confirmed by the F test.

(2) STAR AND KIKUYU GRASS ZONE

Phosphate and farmyard manure trial. In 1952 a 2³ factorial experiment was put down at Embu. It was arranged in blocks of four plots with two blocks per replication and four replications, confounding second order interaction. The treatments were ridging versus nil, mulching versus nil and farmyard manure at 5 tons per acre versus nil. This ran for three years until 1954 with reapplication of the farmyard manure treatments in each year. There were consistent responses to this manuring, but little and variable response to the other treatments. In 1955 the ridging treatment was replaced by reapplication of 5 tons/acre of farmyard manure versus nil. The original farmyard manure treatment, now consisting of three annual 5-ton applications, was left for residual, and the mulching treatment was replaced by 1 cwt. of double superphosphate to the acre. The experiment was planted to maize.

2 × 2 Table of Treatment Means.—Yields in lb. of dry maize grain per acre

	Phosphate	No Phosphate	Means
Residual of three × 5 tons FYM ..	3892.5	3257.5	3575.0
No Residual FYM	3275.0	2195.1	2735.0
Reapplied 5 tons FYM	3535.0	2640.1	3087.5
No reapplied FYM	3632.5	2812.5	3222.5
Mean	3583.7	2726.3	3155.0 = General Mean

	Reapplied 5 tons FYM	No reapplied FYM	Mean
Residual of three × 5 tons FYM ..	3537.5	3612.5	3575.0
No Residual FYM	2637.5	2832.5	2735.0

L.S.D. between marginal means at 5 per cent level = 529 lb. per acre.

L.S.D. between marginal means at 1 per cent level = 725 lb. per acre.

L.S.D. in the body of the table at 5 per cent level = 749 lb. per acre.

L.S.D. in the body of the table at 1 per cent level = 1,026 lb. per acre.

The response to 1 cwt. of double superphosphate per acre was significant in every comparison except following three previous 5-ton FYM applications. However, even there, it approached significance at the 5 per cent level and increased the mean yield by more than three bags to the acre. The residual effect of the FYM application was also statistically significant. The reapplied 5 tons of FYM gave no response when applied after previous FYM manuring, neither

did it increase yields on the plots which had had crops for three previous years but no previous manuring. It has been noted elsewhere that after several years of cropping light dressings of farmyard manure are often ineffective although reapplication in ensuing seasons will build up good responses.

EXPLORATORY FERTILIZER TRIAL

This experiment was started at Embu in 1952 as an initial exploratory trial on fertilizer responses. Treatments were sulphate of ammonia at 0, 1 and 2 cwt. per acre, double superphosphate at 0, 1 and 2 cwt. per acre and muriate of potash at 0, $\frac{1}{2}$ and 1 cwt. per acre. These were combined in two replications of a 3^3 factorial experiment arranged in 9-plot blocks, confounding the NPK interaction. In 1952 and 1953 the full treatments were applied. In 1954 the nitrogen and potash treatments were reapplied. In 1955 nitrogen only was reapplied and the dressings were 0, 2 and 4 cwt. per acre of sulphate of ammonia, half the dressing being applied at sowing time and half when the maize crop was about knee high. In previous years regular phosphate responses on maize had been recorded but no nitrogen responses; the nitrogen before 1955 had been applied at knee high stage only.

Summary tables of means.—Yields in lb. of dry maize grain per acre

	P0	P1	P2	K0	K1	K2	Mean
N0	1,973.2	2,420.0	3,176.4	2,603.2	2,453.2	2,513.2	2,523.2
N1	2,703.2	3,160.0	3,771.6	3,341.6	3,096.4	3,196.4	3,211.6
N2	3,010.0	2,963.2	3,456.4	3,763.2	2,680.0	2,986.4	3,143.2
Mean	2,562.0	2,847.6	3,446.8	3,236.0	2,743.2	2,898.8	2,959.3 =GM

	K0	K1	K2
P0 ..	3,176.4	1,843.2	2,666.4
P1 ..	2,943.2	2,833.2	2,766.4
P2 ..	3,588.4	3,553.4	3,263.2
Mean ..	3,236.0	2,743.2	2,898.8

The L.S.D. at the 5 per cent level of *t* between marginal means = 551.6 lb./acre.
The L.S.D. at the 1 per cent level of *t* between marginal means = 750 lb./acre.

The *F* test showed significant differences due to the main effects of N and P applications only. The year's results can therefore be summarized as showing a significant response to the residual of the higher level of phosphate application at the 1 per cent level when compared to N0 phosphate, and at the 5 per cent level when compared to the residual of the lower phosphate level. In addition a significant response to the use of nitrogenous manuring was shown for the first time at Embu at both levels of application.

An observational trial on the management of permanent pasture at Embu.
In 1953 an observational trial was started on twelve acres of permanent pasture that developed naturally after the clearing of secondary bush in 1952. Rotational grazing of six one-acre paddocks was compared to non-rotational grazing of one six-acre paddock. Pasture composition was assessed by a point quadrat method prior to the start of grazing and shortly after the onset of each of the two rainy seasons in the year.

Total Grazing Days per acre per year

	1953	1954	1955
Rotational grazing.	362	205	93
Non-rotational grazing	304	209	120

Mean percentage composition. Rotational Grazing

	<i>Cynodon dactylon</i>	<i>Panicum maximum</i>	<i>Digitaria scalarum</i>	Other (Weed) Grasses	Legumes	Weeds	Bare Ground
June, 1953 . .	17.4	7.5	18.1	1.5	0.7	0.1	54.4
June, 1956 . .	12.5	5.5	20.4	4.0	1.3	8.1	47.9
Change . .	-4.9	-2.0	+2.3	+2.5	+0.6	+8.0	-6.5

Non-Rotational Grazing

	<i>Cynodon dactylon</i>	<i>Panicum maximum</i>	<i>Digitaria scalarum</i>	Other (Weed) Grasses	Legumes	Weed	Bare Ground
June, 1953 . .	16.2	12.3	20.4	2.4	1.5	1.6	46.1
June, 1956 . .	10.8	6.9	12.8	9.6	1.0	8.4	51.0
Change . .	-5.4	-5.4	-7.6	+7.2	-0.5	+6.8	+5.1

The results show a sharp decline in the productivity of the grazing during the first three years of the experiment. Changes in pasture composition show a decrease in the desirable species *Cynodon dactylon* and *Panicum maximum* under both treatments, and an increase in weed and weed grasses. Under non-rotational grazing the African couch grass, *Digitaria scalarum*, has decreased. It is a palatable grass and presumably has been repeatedly defoliated by grazing.

IRRIGATION INVESTIGATIONS—RICE VARIETY TRIAL

In the short rains 1954 an initial rice variety trial using some varieties available in East Africa was started in the Mwea. There were nine varieties which are listed in the table below and these were arranged in a randomized block experiment with six replications.

Mean treatment yields in lb. per acre

Sindano	Ambaricore	Shingo La Majani	Peshauri	Faya
4,444	5,016	5,236	3,938	4,510

Senna	Ngindimbo	Rathkayalar	Bungala	General Mean
4,356	4,796	5,016	4,488	4,642

Days from Transplanting to Harvest

Sindano	Ambaricore	Shingo La Majani	Peshauri	Faya
116-117	137-?	121-141	117-118	116-117

Senna	Ngindimbo	Rathkayaral	Bungala
118-132	128-130	128-133	128-130

[illegible]

Shingo La Majani, Ambaricore, Rathkayal and Ngindimbo, which were the highest yielding varieties, were also the slowest maturing varieties and in fact two plots of Ambaricore were abandoned unharvested after the start of the 1955 long rains.

RICE VARIETY TRIAL

In the long rains, 1955, a further randomized block variety trial with three replications and five varieties was put down. The varieties were chosen to include two long-term varieties from the previous short rains trial and three quicker maturing varieties.

Mean Treatment yields in lb. per acre and days from transplanting to harvest

		Ambaricore	Sindano	Senna	Peshauri	Ngindimbo
Yield	..	3,989	3,953	3,542	3,263	2,919
Days	..	120–121	119–127	127–128	120–121	127

Two plots of Ngindimbo and one of Sindano were analysed as “missing” plots after bird damage.

L.S.D. between the means of varieties other than Sindano and Ngindimbo:

$$P_{0.01} = 33.73$$
$$P_{0.05} = 22.26$$

L.S.D. between the means of Sindano and varieties other than Ngindimbo:

$$P_{0.01} = 39.51$$
 $P 0.05 = 26.08$

L.S.D. between the means of Ngindimbo and varieties other than Sindano:

$$P\ 0\cdot01=50\cdot78$$

$$P\ 0\cdot05=33\cdot50$$

L.S.D. between the means of Ngindimbo and Sindano:

$$P\ 0\cdot01=71\cdot9$$

$$P\ 0\cdot05=47\cdot47$$

Ambaricore and Sindano were the highest yielding varieties and the differences observed in the life periods of the varieties observed in the short rains did not appear again in the long rains trial.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), COAST PROVINCE, 1955

Weather Conditions

The weather during 1955 was in the main disappointing. The onset of the long rains was noteworthy for light showers with intermittent dry periods in many areas of the coastal strip. As a result early planting was hazardous. Later in April and May continuous dull weather with copious rain did not provide ideal growing conditions. Cereals in general and maize in particular made poor growth during this period. June was the best growing month of the year, both moisture and sunshine being adequate. This is, of course, unusual for June which is normally hot and dry. However, the good conditions in June were offset by the sharp and prolonged drought which set in at the end of that month and continued, almost unbroken, until December. The short rains, greatly delayed, eventually set in uncertainly and were then prolonged far beyond the time when the dry season has normally set in. As a result good short rains crops were obtained, at least in the southern parts of the coastal strip. In the northern areas the short rains were a partial failure.

Leys

LEY ESTABLISHMENT TRIALS

At Shimba Hills work with various grasses and legumes continued during the year. A number of species of Rhodes grass were tried there for the first time and all showed a good deal of initial promise. Planted Star grass has also produced well during the year, and *Setaria sphacelata* is promising. Amongst the several legumes tried in observation plots at this site *Stylosanthes gracilis* has been outstanding.

Of the grasses first established in 1953 the most promising is *Panicum coloratum* var. *makarikariensis*. In its third year, however its production has been low compared with the initial two years and it is showing a tendency to grow in clumps. Original treatments with (1) 1½ cwt. of double superphosphate per acre, (2) 5 tons farmyard manure per acre and (3) planting on 3-ft. tied ridges, are still showing marked effects. Productivity on the plots which received the farmyard manure and phosphate are markedly better than control while the productivity on the ridged area is markedly the poorest of all, no proper sward having formed.

At Matuga *P. coloratum* var. *makarikariensis* has produced reasonably well and is an outstanding grass for its ease of establishment under uncertain rainfall on poor soils. Various strains of Rhodes grass at Matuga have also shown initial promise during the year.

Cassava

CASSAVA DISEASE RESISTANCE TRIALS

At Matuga observations on the mosaic and brown streak resistance of a number of clones of cassava were completed. This work was a continuation of that reported in the Annual Report for 1953. Seventeen new clones were under observation. All these originated from the mosaic-resistant types bred at Amani. Single rows of 35 plants of each clone alternated with rows of diseased material collected from African holdings in various parts of Kwale District. These alternate rows of local material were heavily infected with both mosaic and brown streak throughout the trial.

Records of the incidence of mosaic on individual plants of the 17 clones were taken at regular intervals for one year. The incidence of mosaic was generally slight from the time of planting in April, 1954, until December of that year. From December onwards, as the dry season progressed, the incidence of mosaic rose sharply until the plants were lifted in April, 1955, when mosaic infection was heavy in most of the clones. During the trial certain plants appeared to recover from a mild attack of mosaic, being first recorded as infected and later as free from the disease. In a very few cases the recovery appeared to be genuine, the plants remaining free from infection until the end of the trial. However, in the majority of cases, mosaic was recorded again before the trial was completed. The percentage of mosaic in the various clones after 12 months' growth is presented in Table 1.

At 12 months after planting the plants were dug up and the roots examined for brown streak. The incidence of this disease was very slight. Fifteen of the clones were free from it and one showed slight symptoms only. The remaining clone was severely infected. The status of the clones with regard to brown streak infection in the roots is also shown in Table 1.

Table 1.—Percentage of Plants Showing Mosaic at 12 months after Planting and the Status of each Clone regarding Brown Streak Infection in the Roots at the Same Date

Clone	Origin	Mosaic	Brown Streak
47105/A ..	Cassava x <i>M. glaziovii</i> ..	21.7	Free
4723A/29 ..	" "	33.3	Slight (6.7%)
4760A/2 ..	" "	39.1	Free
4771A/13 ..	" "	37.5	Free
4774/28 ..	" "	20.0	Free
4723A/26 ..	" "	50.0	Free
4760/37 ..	" "	50.0	Free
4759/23 ..	" "	66.6	Free
4751/5 ..	" "	35.3	Free
4763/16 ..	" "	10.0	Free
4640/6 ..	" "	47.8	Free
4776/14 ..	" "	25.0	Free
4763/4 ..	" "	23.5	Free
46107/35 ..	" "	59.3	Free
46105/2 ..	" "	70.0	Free
46103/1 ..	" "	96.0	Free
46117/18 ..	" "	79.2	Severe (92.1%)

Cotton

COTTON VARIETY TRIALS

Cotton variety trials of randomized block design were planted at Kibarani and Gede. These compared the varieties UK48, S47 and the local variety N17. The trials were planted exceptionally late, towards the end of May, due to the fact that seed was not available earlier. Yields were low as a result. Of the three varieties UK48 was the most satisfactory, giving generally better yields, and showing a good degree of resistance to Jassids. S47 was not so satisfactory in this respect, but was still considerably better than N17. The main results are summarized Table 2.

Table 2.—Yields of Seed Cotton in lb. per acre with the percentage of BR Grade Cotton

SITES	VARIETIES			S.E.	L.S.D. 5%
	S47	UK48	N17		
Kibarani—					
Yield	653	779*	621	±45.1	142.0
Per cent BR ..	18.7	22.4	20.7		
Gede—					
Yield	589	649	603	±19.1	66.1
Per cent BR ..	27.1	24.1	21.9		

MAIZE AND COTTON INTERPLANTING TRIALS

Randomized block trials, to compare interplanting of cotton and maize with pure stands of both crops, were planted at Kibarani and Gede. The treatments were:—(a) Plots divided, half sown to maize and half to cotton in pure stands, maize sown early in April. (b) Maize and cotton interplanted according to local custom, maize sown early April. (c) Maize and cotton interplanted according to local custom, maize sown late April. (d) Maize and cotton interplanted according to local custom, maize sown early May. In all cases cotton was sown in early May. A basic application of 5 tons per acre of farmyard manure was put on at both sites. The main results are presented in Table 3 and may be summarized as follows:—

- (a) At Gede half an acre of pure stand maize outyielded one acre of interplanted maize sown at the same time. There was a steady fall in yield of maize according to the lateness of planting. There were no significant differences between cotton from the different treatments. Half an acre of pure stand cotton yielded as much as one acre of interplanted cotton.
- (b) At Kibarani the maize yields were higher all round than at Gede but were of the same pattern. On the other hand interplanted cotton yielded better than pure stand cotton mainly due to the fact that the concentration of cotton in the interplanted plots was heavier than at Gede, representing the closest spacing of cotton found in African cultivation.

Table 3.—Mean yields in lb. per acre for Treatments (b), (c) and (d) and in lb. per half-acre for Treatment (a), with the Percentage of BR Grade Cotton for each Treatment

SITES	(a)	(b)	(c)	(d)	S.E.	L.S.D.	
						5%	1%
Gede—							
Maize grain ..	1,045	888	549	370	±42.7	136.5	196.0
Seed Cotton ..	546	558	551	596	±29.0	92.8	—
% BR Grade Cotton ..	42.7	43.5	43.2	43.1	±1.8	5.7	—
Kibarani—							
Maize grain ..	1,307	1,006	819	480	±38.8	124.1	178.2
Seed Cotton ..	639	1,048	907	1,039	±49.9	159.5	229.2
% BR Grade Cotton ..	28.3	32.1	33.7	28.9	±2.2	7.0	—

COTTON AND GROUNDNUTS INTERPLANTING TRIAL

A randomized block trial, to compare pure stands of groundnuts and cotton with these two crops planted in alternating rows both on the flat and on 3-ft. tied ridges, was put down at Kibarani. The treatments were as follows:—(a) Groundnuts in pure stand; flat cultivation. (b) Groundnuts in pure stand; 3-ft. tied ridges. (c) Cotton in pure stand; flat cultivation. (d) Cotton in pure stand; 3-ft. tied ridges. (e) Cotton and groundnuts; two rows of cotton alternating with four rows of groundnuts; flat cultivation. (f) Cotton and groundnuts; two rows of cotton alternating with four rows of groundnuts; 3-ft. tied ridges. The variety of cotton was S47 and the groundnuts were of the spreading variety grown locally. The cotton was spaced at 3 ft. $\times$ 1½ ft. and the groundnuts at 1 ft. $\times$ 1 ft. The alternating four rows of groundnuts supplanted one row of cotton.

Cotton on 3-ft. tied ridges outyielded cotton planted on the flat, increasing the cash return per acre by Sh. 197/20. Groundnuts on 3-ft. tied ridges did not give a better return than groundnuts planted on the flat. Cotton and groundnuts grown together on the flat gave a significantly better return than either crop grown in pure stand on the flat. In the case of cotton and groundnuts grown on 3-ft. tied ridges the cotton was good and the groundnuts poor, probably due to the suppressing effect of the strong growth of the cotton. The results are presented in Table 4.

Table 4.—Value of Crops in Shillings per acre*
Treatments

(a)	(b)	(c)	(d)	(e)	(f)	S.E.	L.S.D.	
							5%	1%
520.00	545.20	502.80	700.00	642.00	689.20	± 32.68	98.40	136.00

*AR cotton at 50 cts. per lb.

BR cotton at 23 cts. per lb.

Groundnuts at 50 cts. per lb.

Groundnuts

GROUNDNUT VARIETY TRIAL

A variety trial, of randomized block design, was put down at Matuga. The varieties included were:—(1) Barberton, (2) Uganda Bunch, (3) Brown Rapenda, (4) Ahero, (5) Natal Common, (6) Maito, (7) the local spreading variety. The blocks were divided into three strips for: (a) No phosphate, (b) phosphate at ½ cwt. of double superphosphate per acre and (c) phosphate at 1½ cwt. of double superphosphate per acre. The phosphate was placed at planting time, cultivation was on the flat, and spacing was in rows 2 ft. 6 in. apart, and the within-row spacing was 6 in. apart.

Cercospora personata was a serious disease on the varieties Barberton and Natal Common, causing heavy premature defoliation. Nevertheless these two varieties, together with Maito, were the best yielders. *Fusarium* wilt occurred to a slight extent in all varieties with no significant differences in resistance evident. There was also slight infection of all varieties with Rosette disease with some small significant differences in the incidence on different varieties, which may indicate differential resistance. Phosphate at the rate of ½ cwt. double superphosphate per acre increased the yield of groundnuts throughout the experiment

by 13.9 per cent, while the $1\frac{1}{2}$ cwt rate increased the yield by 30.5 per cent. The use of phosphate caused a general improvement in the stand. The main results are presented in Tables 5 (a) and 5 (b).

Table 5 (a).—Mean Yield of Unshelled Groundnuts, lb. per acre

Barberton	Uganda Bunch	Brown Rapenda	Ahero	Natal Common	Maito	Local
1,007	945	910	902	1,033	1,031	824

S.E. = ± 43.1

Least significant differences 5% 127.8; 1% 175.2

Table 5 (b).—Percentage of Plants in the Stand Infected with Wilt and Rosette

	Barberton	Uganda Bunch	Brown Rapenda	Ahero	Natal Common	Maito	Local	L.S.D. 5%
% Wilt ..	0.87	1.08	1.22	0.69	2.01	1.08	1.28	1.07
% Rosette	0.03	2.60	1.77	3.13	0.63	1.56	1.77	1.70

Land Resting

SHORT-TERM RESTS

A $4 \times 2 \times 2$ factorial trial, in two replications of a 2^4 design, was started at Matuga in 1953 to test the effect of short-term annual resting crops. The treatments were as follows:—

(a) Annual treatments.— a_1 , long rains sorghum, short rains beans, continuous cultivation; a_2 , long rains sorghum, short rains Teff grass dug in; a_3 , long rains sorghum, short rains velvet beans dug in; a_4 , long rains sorghum, short rains velvet beans cut and used as a mulch.

(b) Farmyard manure at $3\frac{1}{2}$ tons per acre (M) vs. nil (1953).

(c) 1 cwt. double superphosphate (P) vs. nil (1953).

The Teff grass and velvet beans were interplanted each year in the sorghum before harvesting. All cultivations were on 3-ft. tied ridges. On treatments a_1 , a_2 and a_3 , the ridges were split annually at the end of the short rains, the crop residues, Teff grass or velvet beans, being thus incorporated in the centre of the new ridges. The ridges under treatment a_4 were moulded up annually.

The growth of Teff grass and velvet beans was poor each season due to inadequate rainfall for proper establishment at planting near the end of the long rains. As a result the cover was composed largely of arable weeds, mainly the abundant *Tridax procumbens*.

In the 1953 long rains crop of Dwarf Hegari sorghum the manure and phosphate treatments produced no significant increases in yields. In 1954 the residual effects of the 1 cwt. per acre application of double superphosphate, the $3\frac{1}{2}$ tons per acre application of manure, and these two treatments in combination gave significant increases in yield. The different resting crops planted for the short rains

in 1953 did not give significantly different yields nor yields better than the continuous cultivation treatment. In 1955 the residual effects of the dressings of phosphate and manure, applied in 1953, had disappeared. In this year, however, the effect of the annual treatments with Teff grass incorporated, (a_2), and velvet beans incorporated, (a_3), gave significantly better yields than either continuous cultivation, (a_1), or velvet beans used as a mulch, (a_4). The main results for this experiment for the three years are presented in Tables 6 (a) and 6 (b). Other experiments on land resting continue, but have not yet reached a stage when they can profitably be reported on here.

Table 6 (a).—Yield of Sorghum Grain in cwt. per acre

			a ₁	a ₂	a ₃	a ₄	S.E.	L.S.D.	
								5%	1%
1953	..	..	4.42	5.31	4.29	4.42	±0.79	2.33	3.23
1954	..	..	9.99	10.19	10.67	8.19	±0.89	2.69	3.74
1955	..	..	4.45	6.51	7.94	3.74	±0.68	2.07	2.88

Table 6 (b).—Yield of Sorghum Grain in cwt. per acre

			(1)	M	P	MP	S.E.	L.S.D.	
								5%	1%
1953	..	..	3.97	4.06	5.18	5.22	±0.79	2.33	3.23
1954	..	..	7.03	9.81	9.99	12.21	±0.89	2.69	3.74
1955	..	..	5.70	4.44	6.55	6.45	±0.68	2.07	2.88

Fertilizers

DISTRICT EXPLORATORY FERTILIZER TRIALS

A trial with the three nutrients, nitrogen, phosphate and potash, was laid down at a number of sites on the Magarini sands of the coastal strip. One block of the trial, consisting of eight .025 acre plots, was planted at each of the following sites:—

Malindi district	..	..	..	Kakayuni.
Kilifi district	..	..	..	Kadizinuni and Sokoke.
Kwale district	..	..	..	Tiwi, Kikononi and Gurweni.

The treatments were:—

N at two levels } $N_1 = 1$ cwt. sulphate of ammonia per acre.
 } N_0

P at two levels } $P_1 = 1$ cwt. double superphosphate per acre.
 } P_0

K at two levels } $K_1 = 1$ cwt. muriate of potash per acre.
 } K_0

The crop of Dwarf Hegari sorghum planted at all sites varied greatly in yield according to the rainfall of the area and at Gurweni the crop was a failure. Highly significant increases in yields for nitrogen and phosphate were recorded.

The results for this long rains crop are presented in Table 7. The short rains crop of green gram was a failure at the sites in the Kilifi and Malindi districts due to the lack of rain. Where short rains crops were obtained the residual effect of phosphate was evident in higher yields.

Table 7.—Mean Yields of Sorghum Seed in cwt. per acre

N ₀ 5.37	N ₁ 7.09	
P ₀ 4.92	P ₁ 7.54	S.E. = ± 0.323
K ₀ 6.03	K ₁ 6.43	
L.S.D. between main effect means		
5 per cent 0.92		
1 per cent 1.24		

FERTILIZER TRIAL

A single replicate of a 3³ factorial trial was put down at a new site at Shimba Hills to study further the general responses to the three nutrients, nitrogen, phosphate and potash. The treatments were:—

N at three levels	2 = 2 cwt. sulphate of ammonia per acre.
	1 = 1 cwt. sulphate of ammonia per acre.
	0
P at three levels	2 = 2 cwt. double superphosphate per acre.
	1 = 1 cwt. double superphosphate per acre.
	0
K at three levels	2 = 1 cwt. muriate of potash per acre.
	1 = $\frac{1}{2}$ cwt. muriate of potash per acre.
	0

All cultivations were on 3-ft. tied ridges and the fertilizers were placed at planting time. In the long rains a crop of Dwarf Hegari sorghum was planted. This showed spectacular responses to phosphate, while the effects of nitrogen and potash were not significant. The results for this long rains crop are summarized as follows:—

Table 8.—Mean Yields of Sorghum Grain in cwt. per acre

N ₀ =6.94	N ₁ =7.93	N ₂ =8.73
P ₀ =1.58	P ₁ =10.41	P ₂ =11.62
K ₀ =7.29	K ₁ =7.36	K ₂ =8.95
S.E. = ± 0.70		
L.S.D. between main effect means		
5 per cent = 2.12		
1 per cent = 2.93		
0.1 per cent = 4.04		

In the short rains, without reapplication of the fertilizers, a crop of green gram showed good responses to the residual phosphate. The main results of this crop were as follows:—

Table 9.—Mean Yields of Green Gram Seed in lb. per acre

N ₀ 458	N ₁ 350	N ₂ 358
P ₀ 237	P ₁ 405	P ₂ 524
K ₀ 342	K ₁ 406	K ₂ 418
S.E. = ± 44.9		
L.S.D. between main effect means		
5 per cent 135.36		
1 per cent 187.19		

A similar trial at Kibarani, now in its third year of cultivation, was also planted with Dwarf Hegari sorghum in the long rains. All three nutrients were reapplied for the third year in succession by placement at planting time. The crop was generally very poor, mainly due to poor rainfall at establishment and a consequently thin stand. Significant responses were obtained for nitrogen but not for phosphate or potash. No short rains crop was grown because of drought. The main results for the long rains crop were as follows:—

Table 10.—Mean Yields of Sorghum Grain in cwt. per acre

$N_0=1.48$	$N_1=4.79$	$N_2=6.59$
$P_0=3.44$	$P_1=4.33$	$P_2=5.10$
$K_0=3.87$	$K_1=3.98$	$K_2=5.01$
S.E. = ± 0.81		
L.S.D. between main effect means 5 per cent = 2.45		
1 per cent = 3.38		

The third replicate of this trial at Matuga continued in its fourth year. After two years of a cereal crop in the long rains and a legume crop in the short rains, it was planted with *Panicum maximum* in the long rains of 1954, all three fertilizers being reapplied at that time of planting. The first cut of hay of this trial in 1955 was taken in early May. Residual effects of the phosphate applied in 1954 were still evident, but the effects of nitrogen and potash had disappeared. The effect of potash had, in fact, been very slight in 1954. These two nutrients were reapplied after the first cut. In the second cut in July residual effects of phosphate were again recorded and the reapplied nitrogen gave significant responses but potash was without significant effect. The main results for these two cuts are presented in Table 11. No further cuts were possible during the year due to prolonged drought.

Table 11.—Mean Yields of Hay in cwt. per acre

						May Cut	July Cut
N_0	..	..	..	..	..	46.1	31.7
N_1	..	..	..	..	..	44.1	40.2
N_2	..	..	..	..	..	49.9	53.3
P_0	..	..	..	..	..	37.1	36.4
P_1	..	..	..	..	..	46.5	40.7
P_2	..	..	..	..	..	56.5	48.1
K_0	..	..	..	..	..	48.9	39.8
K_1	..	..	..	..	..	45.9	43.8
K_2	..	..	..	..	..	45.2	41.6
L.S.D. between main effect means:							
5 per cent..						8.9	9.2
1 per cent..						12.3	12.8

TYPES OF PHOSPHATE

At Shimba Hills, where very considerable responses to double superphosphates are obtained, a single replicate of a 3^3 experiment was laid down to compare the effects of other forms of phosphate with double superphosphate. A previous trial along these lines had been abandoned because of the unsuitability of the site. The treatments were as follows:—

Types of phosphate:

$T_2=816$ lb. Uganda rock phosphate per acre.

$T_1=600$ lb. Guano per acre.

T_0

Double superphosphate at three levels:

P_2 = 2 cwt. of double superphosphate per acre.
 P_1 = 1 cwt. of double superphosphate per acre.
 P_0

Three repetitive treatments to be applied in 1956:

R_2 = 816 lb. Uganda rock phosphate per acre.
 R_1 = 600 lb. Guano per acre.
 R_0

Due to the difficulty of getting the fertilizer in time, planting of the sorghum crop on this trial was very late. The exceptional mid-year drought combined with late planting resulted in a crop which it was judged would produce little or no grain. It was therefore decided to harvest the sorghum as a green fodder crop in order to obtain some data. This harvest showed big responses to double superphosphate with smaller, but still substantial, responses to guano and Uganda rock. This sorghum crop was followed by a crop of green gram in the short rains. The response to the residual effect of the higher level of double superphosphate was the only fully significant response (5 per cent) in this crop. A response which failed to reach this level of significance was obtained for the Uganda rock. The main results can be presented as follows:—

Table 12 (a).—Mean Yields cwt. of Sorghum Fodder per acre (Long Rains Crop)

T_0	40	T_1	51	T_2	55
P_0	29	P_1	59	P_2	57
S.E. = ± 3.15					
L.S.D. between main effect means					
				5 per cent	9.5
				1 per cent	13.1

Table 12 (b).—Mean Yields of Green Gram Seed in lb. per acre (Short Rains Crop)

T_0	478	T_1	562	T_2	551
P_0	457	P_1	512	P_2	621
S.E. = ± 32.05					
L.S.D. between main effect means					
				5 per cent	96.6
				1 per cent	133.6

A similar trial at Matuga which was in its third year of cropping did not show any residual effects to any of the phosphate treatments. The T and P treatments had been applied in 1953 and the R treatments in 1954. At this site the effects of double superphosphate have been small throughout the trial and the effects of guano and Uganda rock insignificant.

RATES OF APPLICATION OF PHOSPHATE AND MANURE

The 3^3 factorial trials, of two replicates each, started at Matuga and Shimba Hills in the long rains in 1953 continued in 1955. At Matuga the full treatments since the commencement of the experiment were as follows:—

Three levels of manure:

M_2 = 5 tons manure per acre (applied 1953).
 M_1 = $2\frac{1}{2}$ tons manure per acre (applied 1953).
 M_0

Three levels of phosphate:

P_2 = 1 cwt. double superphosphate (applied 1953).
 P_1 = $\frac{1}{2}$ cwt. double superphosphate (applied 1953).
 P_0

Three repetitive treatments:

R_2 = 1 cwt. double superphosphate (applied 1954).
 R_1 = $\frac{1}{2}$ cwt. double superphosphate (applied 1954).
 R_0

Blocks consist of nine .025 acre plots, with 3 ft. discards between plots. The second order interaction is confounded.

Last year there had been residual effects of the 1953 application of phosphate and responses to repetitive phosphate applied in that year, but no residual effect of manure. In the 1955 crop of Dwarf Hegari sorghum, planted in the long rains, no significant responses were recorded. A crop of green gram, however, planted in the short rains produced an excellent crop in the presence of adequate rainfall late in the season. In this crop the main effects of all treatments were statistically significant although resulting differences in yield were small. It serves to underline the fact that inadequate moisture, in this area of uncertain rainfall and excessively drained light sands, so often dominates an experiment reducing all treatments to a common low level of production. The main results for the year are presented as follows:—

Table 13 (a).—Mean Yields of Sorghum Seed in cwt. per acre (Long Rains)

M ₀	6.81	M ₁	5.40	M ₂	6.19
P ₀	6.45	P ₁	7.47	P ₂	4.48
R ₀	5.99	R ₁	6.69	R ₂	5.72
S.E. = ± 0.46					
L.S.D. between main effect means 5 per cent 1.34					
1 per cent 1.82					

Table 13 (b).—Mean Yields of Green Gram Seed in lb. per acre (Short Rains)

M ₀	537	M ₁	602	M ₂	584
P ₀	538	P ₁	585	P ₂	600
R ₀	525	R ₁	579	R ₂	619
S.E. = ± 15.8					
L.S.D. between main effect means 5 per cent 46.2					
1 per cent 62.8					

A similar trial laid down at Shimba Hills at the same time as the above experiment at Matuga gave inconclusive results.

Ridging, Mulching and FYM Trials

The 2³ factorial trial started with replicates at Matuga, Shimba Hills, and Gede in 1952 continued for the fourth year at Shimba Hills. The trial compared all combinations of the following treatments:—

- (a) 3-ft. tied ridges vs. flat cultivation.
- (b) 10 tons farmyard manure per acre vs. nil.
- (c) Mulch of dry grass vs. nil.

This trial was allowed to continue for one more year than was originally intended because residual effects of the manure applied in 1952 had proved outstanding even in the third year of cultivation. Due to the vagaries of the season no long rains crop was obtained but a short rains crop of velvet beans was very productive and in scoring showed clear increases for ridging vs. flat cultivation, annual mulching vs. none, and a much smaller but still significant increase for 10 tons of manure applied in 1952 vs. none. There were no significant interactions. The results for the main effects can be presented as follows:—

Table 14.—Mean Scores for Main Effects. Plots Scored out of 10

Flat	Ridged	No Manure	Manure	No Mulch	Mulch
5.85	7.50	6.35	7.00	5.70	7.65

S.E. of main effect mean = ± 9.22 L.S.D. between main effect means 5 per cent 0.65
1 per cent 0.89

Another trial, to compare different sizes of ridges, annual splitting vs. annual moulding up, and deep vs. normal placement of fertilizer in these ridges gave inconclusive results due to the fact that phosphate deficiency of the soil reduced all, except the fertilizer treatments, to a common level.

METHODS OF APPLICATION OF FARMYARD MANURE AND RESIDUAL EFFECTS

This trial consisting of 4 series, each of 3 randomized blocks, with 6 plots per block, continued at Matuga in its third year of cultivation. The treatments are as follows:—

- Application of manure: nil; 9 tons in the first year; 3 tons in each of 3 years.
- A rotation of four crops: sorghum, followed by beans in short rains, cotton, maize followed by beans in short rains, and cassava.
- A dressing of fertilizer equivalent in nutrients to the 3-ton dressing of manure, applied in each year.

The crop in Series I in the long rains was maize. It yielded poorly, suffering a severe check through drought at the end of June. This crop showed significant increases over control for the 9-ton dressing of manure applied in 1954 and for the 9-ton dressing applied in 1955. The residual effect of the 1953 9-ton dressing had largely disappeared, while the yield from the 3-ton annual dressing was not significantly better than control; neither was the equivalent dressing of fertilizers.

Cassava was planted in Series II and had not been harvested at the end of the year. Visual examination revealed no treatment differences.

A crop of Dwarf Hegari sorghum was planted in Series III in the long rains. Here the residual effects of the 1953 9-ton dressing of manure had disappeared, but the remaining four treatments all gave very significantly higher yields than control.

On Series IV a poor crop of cotton was produced. The only significant effect was for the nine tons of manure applied in 1955.

The main results are presented in Table 15:—

Table 15

(a) Mean Yields of Maize from Series I in cwt. per acre—

9 TONS OF MANURE IN			3-ton Annual Dressing	Equivalent Fertilizers	Control
1953	1954	1955			
6.43	8.04	7.21	6.89	5.82	5.54

S.E. = ± 0.52

L.S.D. between means 5 per cent 1.64

(b) Mean Yields of Sorghum from Series III in cwt. per acre—

9 TONS OF MANURE IN			3-ton Annual Dressing	Equivalent Fertilizers	Control
1953	1954	1955			
9.36	15.79	17.93	15.64	18.29	8.68

S.E. = ± 0.88 L.S.D. between means 5 per cent 2.81
1 per cent 4.04*(c) Mean Yields of Seed Cotton from Series IV in lb. per acre—*

9 TONS OF MANURE IN			3-ton Annual Dressing	Equivalent Fertilizers	Control
1953	1954	1955			
149	235	256	155	248	204

S.E. = ± 51.6

L.S.D. between means 5 per cent 162.4

Sugar**N.P.K. FERTILIZER TRIAL**

The first ratoon crop of the 3³ factorial trial with nitrogen, phosphate, and potash, laid down at Kenya Sugar Ltd., plantations at Ramisi in December, 1952, was harvested in January, 1955. The treatments, layout, and results of the plant crop have been reported on in the 1954 Annual Report. There was no reapplication of fertilizers on this first ratoon crop. The yields of cane in the ratoon crop had dropped very sharply from the plant crop, from an average of 43.3 tons per acre to 14.73 tons. The main cause of such a serious drop in yield was the very dry conditions during the latter half of 1954. The fertilizer treatments, applied in 1952, did not give significantly different yields in the first ratoon crop, although both nitrogen and phosphate had given big increases in the plant crop. The main results were as follows:—

Table 16.—Mean Yields of Cane in tons per acre for Main Effects in the First Ratoon

No nitrogen.. .. .	14.80
2 cwt. of sulphate of ammonia per acre	14.00
4 cwt. of sulphate of ammonia per acre	15.40
No phosphate	13.45
2 cwt. single superphosphate per acre	15.75
4 cwt. single superphosphate per acre	15.00
No potash	14.30
1½ cwt. muriate of potash per acre	14.10
3 cwt. muriate of potash per acre	15.70

S.E. = ± 1.02 L.S.D. between main effect means 5 per cent 2.98
1 per cent 4.05

NITROGEN, MOLASSES AND FILTER PRESS MUD EXPERIMENT

The randomized block trial with nitrogen, molasses and filter press mud laid down at Ramisi in 1952 continued during 1955, the first ratoon crop being cut in January. The treatments, layout, and results of the plant crop have been reported on. In this case yields had also dropped sharply from the plant crop yields due mainly to drought. Treatments were not reapplied on the ratoon crop. The ratoon crop produced some evidence that nitrogen applied by itself to the plant crop tended to depress the yields of the ratoon crop and that filter press mud had a lasting beneficial effect, but differences in general for all treatments were statistically non-significant. The main results were:—

Table 17.—Mean Yields of Cane in Tons per acre

N ₀	Control	..	..	..	..	13.67
N ₃	3 cwt. sulphate of ammonia per acre	..	..			11.11
N ₆	6 cwt. sulphate of ammonia per acre	..	..			11.39
N ₀ M	3 tons of molasses per acre	..	..	..		15.33
N ₃ M	Treatments N ₃ and M combined	..	..			13.06
N ₆ M	Treatments N ₆ and M combined	..	..			13.66
N ₀ F	10 tons filter press mud	..	..	..	..	14.80
N ₃ F	Treatments N ₃ and F combined	..	..	..		13.93
N ₆ F	Treatments N ₆ and F combined	..	..	..		15.99

S.E. = ± 1.52

L.S.D. between treatments 5 per cent 4.33

1 per cent 5.80

A further fertilizer trial was laid down at Ramisi in the short rains of 1954 to compare all combinations of the treatments, 0, 2, 4 and 8 cwts. of sulphate of ammonia per acre, and 0, $\frac{1}{2}$, 1 and 2 cwts. of double superphosphates per acre. This trial is of a 4×4 factorial design with three replications. This trial was harvested at the end of the year. A full analysis of all data has not been completed but good responses to phosphate and to a lesser extent to nitrogen are obvious from a preliminary examination of the results.

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